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QISMULLAH YUSUF

A COMPARATIVE STUDY OF VOWELS IN THE ACEHNESE LANGUAGE SPOKEN IN KEDAH, MALAYSIA AND ACEH, INDONESIA

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ABSTRACT

Acehnese is still spoken in Kampung Aceh, Kedah, Malaysia (hereafter, KpA), by Acehnese descents who settled in the area in the late 18th century. Today, they comprise the second to the sixth generations. This study aims to describe oral Acehnese vowels to provide more systematic description of these vowels produced by Acehnese speakers in KpA and as a comparison to Acehnese speakers in Aceh, Indonesia (hereafter, Ach) at the present time. The vowels are based on Asyik's (1987) description of Acehnese vowels that comprise ten monophthongs: front vowels /i/, /e/, /ɛ/, central vowels /ɯ/, /ə/, /ʌ/, /a/, and back vowels /u/, /o/, /ɔ/, and 12 diphthongs divided into centering diphthongs (/iə/, /ɯə/, /uə/, /ɛə/, /ʌə/, /ɔə/) and rising diphthongs (/ui/, /əi/, /oi/, /ʌi/, /ɔi/, /ai/). The data were collected in two speaking contexts: vowels in target words based on a wordlist (hereafter, WE) and target vowels in words selected from interviews (hereafter, INT).

The findings from WE and INT indicated that most of the monophthongs vowels by Ach language consultants were generally maintained by KpA language consultants. The sound /ʌ/ was found not to be produced by KpA language consultants, while /ə/ was realized closer to [ɵ], and a new sound [ɑ] detected in INT was starting to emerge in their Acehnese. As for the diphthongs, /iə/, /ɯə/, /uə/, /ɛə/, /ui/, /əi/, /ʌi/ /oi/ /ɔi/ and /ai/ were maintained by Ach language consultants, however, /ʌə/ and /ɔə/ were moving towards the back of the vowel space, suggesting [ʌu] and [ɔu] from both contexts. For KpA language consultants, /iə/ and /ɛə/ were realized as monophthongs of [i] and [ɛ]

from both WE and INT. From WE, these consultants realized /ɯə/ closer to [ɯɨ], and /uə/ closer to /uɯ/. However, from INT, these diphthongs were realized as monophthongs [ɯ] and [u]. The diphthong /ɔə/ was closer to [ɔo] in WE, but maintained in INT. All instances of /əi/ were realized as [oi] from both contexts, /ʌi/ was realized as [ɔe], and /ɔi/ was realized as [oe]. Therefore, the diphthongs maintained were /ɔə/, /ai/, /oi/ and /ui/. An apparent change was seen with the centering diphthongs being produced differently by both sets of speakers. The absence of most of these diphthongs in the Acehnese variety in KpA may be due to the fact that they are not present in the Standard Malay (hereafter, SM) and Kedah dialect (hereafter, KD). This preliminary study has identified some changes that are occurring in the production of the vowels, especially in the variety of Acehnese in KpA.

Additional analysis of SM and KD vowels revealed that the maintenance of most monophthongs by KpA language consultants could be due to the shared qualities of these vowels with SM and KD vowels, such as /i/, /e/, /a/ and /o/. The sounds /ɛ/ and /ɔ/ were similarly produced with KD vowels. The sound /u/ was similar to the Acehnese variety in Ach, but produced more fronted compared to SM and KD /u/. KpA language consultants also produced /ai/ and /oi/ similarly to SM and KD, and /ui/ similarly to KD. The motives for KpA language consultants' sound change and maintenance are seen from their attitudes towards Acehnese language use, identity and efforts to revitalize their mother tongue. From the KpA language consultants' sense of self, they do not just consider themselves as just Acehnese, but as Acehnese Malaysian as well. Their perception of this identity can be recognized from their variety where some sounds are produced differently from the Acehnese variety in Ach.

ABSTRAK

Bahasa Aceh masih lagi dituturkan di Kampung Aceh, Kedah, Malaysia, oleh keturunan Aceh yang menetap di kawasan itu semenjak dari lewat abad ke-18 (selepas ini, KpA). Hari ini, mereka terdiri daripada keturunan dari abad tersebut hingga ke generasi yang keenam. Kajian ini dijalankan untuk memberi penjelasan tentang vokal-vokal pertuturan orang Aceh bagi memberi penerangan yang lebih sistematik tentang bunyi vokal yang dituturkan pada masa kini oleh orang berketurunan Aceh di KpA dan orang Aceh di Aceh, Indonesia (selepas ini, Ach). Vokal-vokal ini adalah berdasarkan pendapat Asyik (1987) yang mana beliau telah membezakan sepuluh monoftong iaitu: vokal depan /i/, /e/, /ɛ/, vokal tengah /ɯ/, /ə/, /ʌ/, /a/, dan vokal belakang /u/, /o/, /ɔ/, dan 12 huruf diftong yang dibahagikan kepada diftong menengah (/iə/, /ɯə/, /uə/, /ɛə/, /ʌə/, /ɔə/) dan diftong meninggi (/ui/, /əi/, /oi/, /ʌi/, /ɔi/, /ai/). Data kajian telah dikumpul dari dua konteks pertuturan: data dari sebutan vokal dari perkataan sasaran di dalam senarai perkataan (selepas ini, WE) dan data dari sebutan vokal di dalam perkataan pilihan dari sesi temu bual (selepas ini, INT).

Hasil dapatan dari WE dan INT menunjukkan kebanyakan vokal monoftong yang digunakan oleh penutur Bahasa Aceh di Ach telah dikekalkan oleh penutur Bahasa Aceh di KpA. Bunyi /ʌ/ didapati tidak dituturkan oleh penutur KpA, manakala /ə/ dikenalpasti lebih menghampiri [ɵ], dan bunyi baru [ɑ] yang dikesan dalam data INT, telah mula wujud di dalam bahasa Aceh mereka. Bunyi diftong /iə/, /ɯə/, /uə/, /ɛə/, /ui/, /əi/, /ʌi/ /oi/ /ɔi/ dan /ai/ pula telah dikekalkan oleh penutur Ach, namun /ʌə/ dan /ɔə/ telah beralih ke bahagian belakang ruang vokal yang dikenali sebagai [ʌu] dan [ɔu] daripada kedua-dua konteks. Bagi penutur Bahasa Aceh di KpA, /iə/ dan /ɛə/ dikenalpasti sebagai monoftong bagi /i/ dan /ɛ/ daripada kedua-dua konteks. Dari WE,

penutur ini mengahsilkan /ɯə/ lebih menghampiri [ɯɨ], dan /uə/ lebih menghampiri /uɯ/. Tetapi, dari INT, kedua diftong ini merupakan monoftong bagi [ɯ] dan [u]. Bunyi /ɔə/ lebih menghampiri [ɔo] dalam WE, tetapi dikekalkan dalam INT. Kesemua contoh bunyi /əi/ disebut [oi] daripada kedua-dua konteks, /ʌi/ pula disebut [ɔe], dan /ɔi/ disebut [oe]. Oleh itu, diftong yang dikekalkan adalah /ɔə/, /ai/, /oi/ dan /ui/. Satu perubahan yang jelas dapat dilihat pada diftong pertengahan yang dituturkan secara berlainan oleh kedua-dua kumpulan penutur. Kebanyakan bunyi diftong pertengahan yang dihilangkan oleh penutur KpA mungkin berlaku disebabkan bunyi ini tidak terdapat di dalam bahasa Melayu Standard (selepas ini, SM) dan dialek Kedah (selepas ini, KD). Kajian awal ini telah memperkenalkan beberapa perubahan yang berlaku di dalam penghasilan bunyi vokal, terutamanya dikalangan orang berketurunan Aceh di Kedah.

Analisis tambahan dari bunyi-bunyi vokal SM dan KD mendedahkan bahawa penutur Bahasa Aceh di KpA menghasilkan bunyi-bunyi vokal /i/, /e/, /a/ dan /o/ yang serupa dengan penutur-penutur SM dan KD. Bunyi /ɛ/ dan /ɔ/ yang dihasilkan juga adalah sama dengan penutur KD. Bunyi /u/ adalah sama dengan penutur Bahasa Aceh di Ach, tetapi lebih depan berbanding penutur-penutur SM dan KD. Penutur KpA juga menghasilkan /ai/ dan /oi/ yang sama dengan SM dan KD, manakala /ui/ pula sama dengan KD. Motif penyelenggaraan dan perubahan bunyi-bunyi vokal oleh penutur KpA dapat dilihat dari sikap mereka dalam menggunakan bahasa Aceh, identiti dan usaha mereka untuk menghidupkan semula bahasa ibunda mereka. Penutur KpA tidak hanya menganggap diri mereka sebagai orang Aceh, tetapi juga sebagai orang Aceh Malaysia. Persepsi mereka terhadap identiti ini boleh dikenali melalui variasi bahasa mereka yang memiliki beberapa bunyi yang berbeza dengan Bahasa Aceh di Ach.

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LIST OF SYMBOLS AND ABBREVIATIONS

Ach	Aceh
KpA	Kampung Aceh
KD	Kedah dialect
SM	Standard Malay
WE	Data from word elicitation
INT	Data from interview
F1	First formant
F2	Second formant
ED	Euclidean Distance
ROC	Rate of Change
SD	Standard Deviation
Ach-WE	Data from WE from Ach language consultants
Ach-INT	Data from INT from Ach language consultants
KpA-WE	Data from WE from KpA language consultants
KpA-INT	Data from INT from KpA language consultants

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CHAPTER 1 : INTRODUCTION

1.1 Introduction

This chapter provides the background for this research. The Acehnese language spoken in Aceh province, Indonesia, is briefly explained followed by a description of the situation in Kampung Aceh, Kedah, Malaysia, and the Acehnese descendents residing here. The statement of problem, objectives of study, research questions and the significance of this research are also presented in this chapter.

1.2 Background

Aceh is located at the northern point of Sumatra in Indonesia. It is a province that is given autonomy by the central government in Jakarta. The province is subdivided into 18 regencies (*kabupaten*) and 5 cities (*kota*). At the coast near the northern tip of the island is Banda Aceh, the capital city of the province.

The official language in Aceh is the national language, Bahasa Indonesia, which is used in the country's formal contexts (e.g. schools, administrations, meetings). Nevertheless, other local languages in the country continue to be used by its people in informal contexts in their everyday life. Although it is not compulsory to teach local languages in public schools, Indonesian law (see Undang-Undang Dasar 1945, Chapter XIII, and Article 32(2) in Redaksi Jogja Bangkit, 2010) declares that local languages of the Indonesians are to be respected and preserved by the government as national cultural treasures (Lumintaintang, 2002; Sulaiman, 1978). Consequently, in many public schools across Indonesia, local languages are taught and included in the school curriculum as an effort to preserve the local languages. In Aceh, Acehnese language is taught in public junior high schools (grades seven to nine) for about two hours a week (Akmal, 2011).

The syllabus includes sentence structures, writing and vocabulary. Likewise, religious schools known as *pesantren* or *dayah* have the same hours of study but this language is taught from elementary up to high school levels. Although Acehnese is still spoken at home in the family and social domains especially in rural villages, it is presently facing increasing competition from Bahasa Indonesia (Akmal, 2011; Alamsyah, Taib, Azwardi & Idham, 2011). It is found that the younger generations of Acehnese are gradually using more Bahasa Indonesia especially in urban areas such as Banda Aceh (see Alamsyah, Taib, Azwardi & Idham, 2011).

1.3 Acehnese Language

Aceh is populated by a number of ethnic groups. The major ethnic groups are the Acehnese, Gayonese, Alas, Tamiang, Aneuk Jame and Kluet (Wu, 2006), with 90% of the population comprising ethnic Acehnese (McCulloch, 2005). Smaller ethnic groups in this province include, among others, the Ulu Singkil and Simeulu (McCulloch, 2005). Other ethnic minorities in this province include the Minangkabau, Javanese and Chinese (Taylor, 2011).

Each ethnic group has their own language or dialect. There are nine main local languages spoken in the province all of which are distinct from each other. They are Acehnese, Alas, Gayo, Tamiang, Aneuk Jamèe, Kluet, Singkil, Simeulu and Haloban (Wildan, 2002). Among these, Acehnese has the most number of speakers numbering approximately 3.5 million (2000 census in Lewis, 2009).

Acehnese is found to be related to the Chamic languages found in southern Vietnam and Cambodia (Asyik, 1987; Durie, 1985; Thurgood, 2007). Malayic languages are its closest non-Chamic relation (Thurgood, 2007); it is considered to be a part of the Malay sub-family of the Indonesian branch of the Austronesian language family (Asyik, 1987; Akbar, Abdullah, Latif & Ahmaddin, 1985). Aceh was the first crucible of "classical" Malay literature in the seventeenth century (Reid, 2005, p. 17), or Jawi Pasai, as the Acehnese called it (Alfian, 2007). Its system of writing was Malay in Arabic script (Reid, 2005). During this period, the Malay language was known to be the lingua franca of the Sultanate of Malacca (from 1400-1511, with a territory covering the Malay Peninsula, Riau Islands and most of the east coast of Sumatra) and had spread to the peninsular of Southeast Asia that rapidly developed under the influence of Islamic literature (Ahmad Sarji, 2011). In the kingdom of Aceh, it was then known that even though the spoken language of the village, in the family and of poetic tradition was Acehnese, communication of the royal courts and written texts of legal letters, documents, scholarships and education was in Malay (Durie, 1996; Reid, 2005). Voorhoeve (1994, p. 14) suggests that the first evidence of the existence of a written literature in Acehnese is '*Hikayat Seuma'un*' that appeared in 1658/1659. When Aceh became a part of Indonesia in 1950 (Reid, 2005), Bahasa Indonesia became the official language in the region.

Acehnese has four main dialect groups (Asyik, 1987, p. 3) that are as follows:

1. The Greater Aceh dialect, spoken in Aceh Besar Regency
2. The Pidie dialect, spoken in Pidie and Pidie Jaya Regencies
3. The North Aceh dialect, spoken in East Aceh, North Aceh and Bireuen Regencies
4. The West Aceh dialect, spoken in the Aceh Jaya, West Aceh, Nagan Raya and South Aceh Regencies

The standard form of Acehnese is considered the North Aceh dialect (e.g. Asyik, 1987; Durie, 1985; Hanafiah & Makam, 1984; Sulaiman, Jusuf, Hanum, Lani & Ali, 1977; Sulaiman, Yusuf, Hanoum & Lani, 1983) because of its consistent language structure and large number of speakers. Durie (1985, p. 6) further states the North Aceh dialect is "the most uniform and numerous in speakers". It is also "phonologically homogeneous" compared to the other dialects in Acehnese (Asyik, 1987, p. 6). This means that there is not much variation in the pronunciation of the North Aceh dialect. The distribution of Acehnese dialects that are spoken in the province is shown in Figure 1.1.

Figure 1.1: Acehnese language map
(reproduced from Hanoum, Sulaiman, Ibrahim & Ismail, 1986, p. xiv)

In the map in Figure 1.1, the lined areas are where Acehnese is largely spoken. The white areas indicate areas where other languages are spoken in the province. The North Aceh dialect is spoken by speakers in Lhokseumawe and the regencies of Bireuen, North Aceh and East Aceh.

1.4 Kampung Aceh

Historically, the relationship between the Sultans in Aceh and the Malay kingdom can be traced back since as early as the 8th century (Reid, 2005) through political struggle, warfare, intermarriage, rich scholarly exchange and trading (Nah & Bunnell, 2005; Reid, 2005). Thus, the main flow of Acehnese immigration to Malaysia started in the late 18th century. It was initiated by the Dutch invasion to Aceh in 1873 (Mitrasing, 2011; Reid, 2005; Smith, 2002), which was occupied until 1942 (Mitrasing, 2011). Further, after Aceh signed over full independence to Indonesia in 1950 (Reid, 2005), a revolt against the Indonesian government occurred in 1953 (McCulloch, 2005; Reid, 2005) by the Acehnese rebellion, Darul Islam, until 1962 (McCulloch, 2005). A continued dissatisfaction and resentment towards Indonesian rule led to another revolt in 1976 by Gerakan Aceh Merdeka (GAM, the Free Aceh Movement) (McCulloch, 2005; Wu, 2006). On December 26, 2004, an 8.9 on the Richter scale earthquake occurred in the Indian Ocean, just 150 km from Aceh and caused 127,000 to be killed, and 116,000 to be missing in the province (McCulloch, 2005). This disastrous event initiated a peace agreement of political reform between the rebellions or GAM and the Indonesian government in August 2005 in Helsinki (see Aspinall, 2005; Aspinall, 2008; Enia, 2008).

Consequently, the three decades of war against the Dutch (Reid, 2005), the conflicts with the Indonesian government and natural disasters have caused social tension, economic and environmental destruction to Aceh (Wu, 2006). These have led many to flee from their homeland across borders (Wu, 2006), and some leaders of the rebellion were exiled to other countries (Aspinall, 2008). Most are known to have fled to Malaysia because of its nearby geographical location, and similar cultural practices have helped eased the process of migration. There, permanent Acehnese settlements were set up in Kedah, Perak, Pinang and Langkawi in Peninsular Malaysia (Nah & Bunnell, 2005).

The first Acehnese migration to Kedah started after 20 years of Dutch colonization in Aceh from 1895-1905 (Abdul Majid, 1980; Panyot Ceulot, 2007). The vast flow of Acehnese arrivals to Yan, Kedah, in the northwest of Malaysia, was from 1888 to 1915 (Azrul, 2012a). Most of them settled in a village named Kampung Aceh (literally "Acehnese Village") that was established around late 1895 by the first Acehnese immigrants in this area (Panyot Ceulot, 2007; Esham, 1998) (see Figure 1.2).

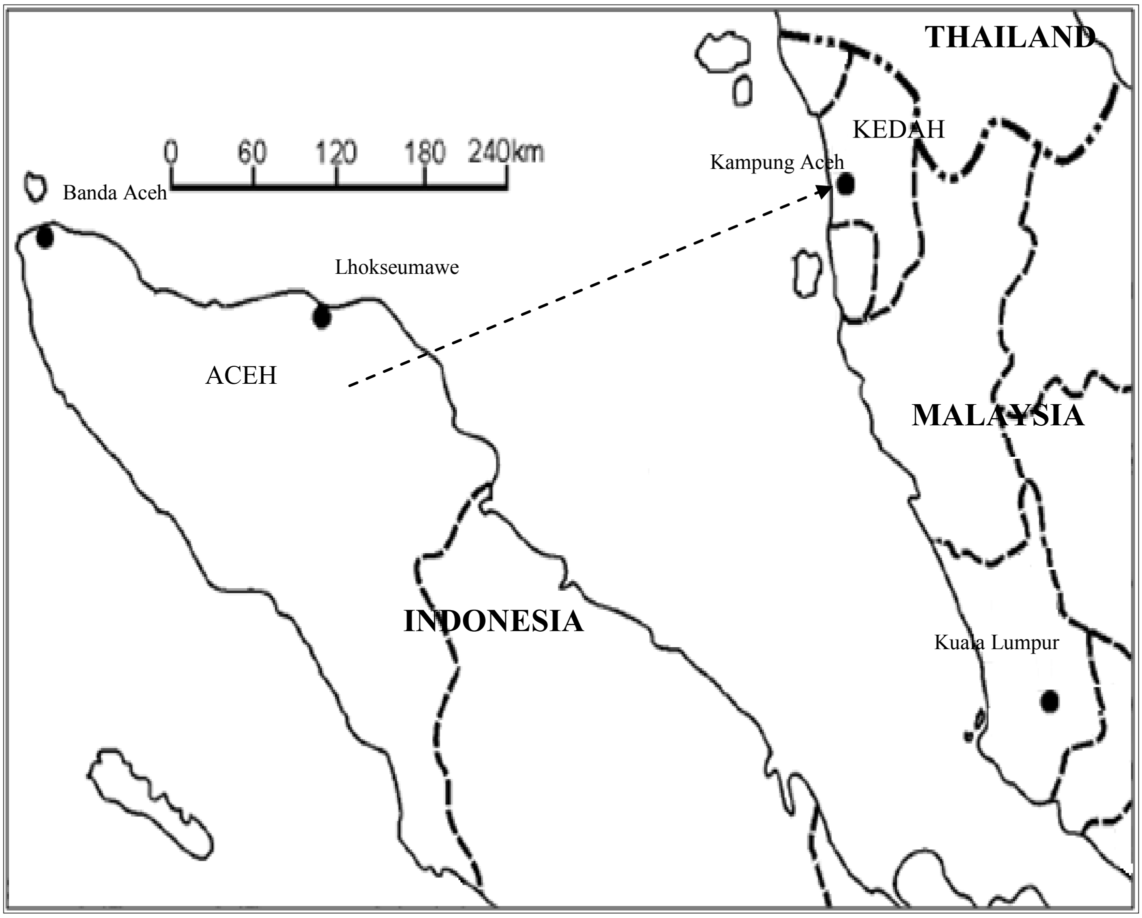


Figure 1.2: Migration to Kampung Aceh from Aceh
(reproduced from Nah & Bunnell, 2005, p. 251)

Esham (1998) also adds that during the first migration in 1895, only 35% of the Acehnese people continued to settle in Kampung Aceh, while others returned to Aceh, and some travelled along the Straits of Malacca to Pulau Pinang, Pahang, Kedah, Perak and Johor (Panyot Ceulot, personal communication, August 29, 2008).

Furthermore, Esham (1998) states that the relationship between Kedah and Aceh began as early as the 13th century. He further says that Kedah was once under the ruler of Pasai in the late 13th century. Pasai was one of the oldest Acehnese kingdoms, which was formed through the merger of Peureulak and Pasé kingdoms at the time. Hussain (1982, as cited in Esham, 1998) also explains that later Kedah and Aceh had a strong relationship and this can be noted from an area in Banda Aceh named Kampung Kedah (literally “Kedah village”), which was initially given by one of the Acehnese Sultans in the late 1800s as a residential area for the Sultan of Kedah whenever he visited the Acehnese kingdom with his followers during the time. During the earthquake and tsunami that hit the region on December 26, 2004, however, most of this area was submerged as it is near the sea.

1.4.1 Acehnese Descents in Kampung Aceh

According to Panyot Ceulot (2007), the Acehnese who initially settled in the villages of Kampung Merbok and Kampung Singkir in Yan, Kedah, were from Pidie, Greater Aceh, North Aceh and East Aceh. The first group of Acehnese was believed to be *ulamas* (Muslim scholars trained in Islam and Islamic law) led by Teungku Po Cut Haji bin Po Balee, Cut Leh bin Cut Yusoh and *ulèebalangs* (the heads of various regencies in Aceh at the time or regional chieftains). Later, as more Acehnese arrived in the region, they established a village known as Kampung Aceh, which was originally an integration of three existing villages during that time, known as Kampung Sulub, Kampung Lubuk Kasai and Kampung Lubuk Panjang.

Until today, Kampung Aceh (hereafter, KpA) is still populated predominantly by Acehnese descents that at present comprise the third to the sixth generations. A survey conducted in 2008 shows that there were approximately 126 residents in the village with 104 of them being Acehnese descents (Yusuf, Pillai & Mohd. Ali, 2013). Acehnese descents who are Malaysian are categorized as “Malay”, as specified by the constitutional definition of “Malay” in Malaysia (Nah & Bunnell, 2005, p. 225). Table 1.1 shows the number of Acehnese descendents in Kampung Aceh. The demographic data was collected in 2008 during the first survey to KpA that was conducted for this purpose.

Table 1.1: Number of Residents of Acehnese Descents in Kampung Aceh in 2008
(reproduced from Yusuf, Pillai & Mohd. Ali, 2013, p.51)

Generation	Age	Males	Females	Total # of People
2nd	81-100	1	3	4
3rd	61- 80	6	13	19
4th	41- 60	11	18	29
5th	21- 40	5	10	15
6th	0 – 20	20	17	37
Total		43	61	104

The Acehnese easily assimilated into the Malay society due to similar beliefs and culture. Some houses, which were built in the early 1900s in the style of Acehnese traditional houses, are still well preserved in the village, though most have been destroyed due to decay of the wood and have been replaced with concrete homes. Families still live in the ones that have been preserved.

There is one small local mosque or *meunasah* in the village that was first built by the second generation in 1902, named Al-Irsyadi. Abdurrahman (personal communication, August 29, 2008) observes that the true concept of the Acehnese people is to *"peugèt meunasah pat-pat ta-duek"* (build a *meunasah* in the place we live in). Until today, the people of the village still gather in the *meunasah* for meetings and events. This practice is similar to the Acehnese in Aceh province, both in villages or cities.

Most Acehnese from the third and some from the fourth generation finished their secondary school studies in English medium schools. During the British occupation of Malaysia, English schools were set up, and it was only in the 1970s that Malay became the medium of instruction in schools (see Pillai, 2012). Most of the Acehnese elders in KpA had attended the Ibrahim School, established in 1919, which was a well-known government English school in Kedah during its time. The Acehnese residing in KpA are employed in government offices or are self-employed.

Acehnese culture is still evident in KpA. The traditional *kulét* (the dried skins of cows or buffalos), *asam sunti* (dried and salted *boh limeng*, a fruit from the star fruit family used in Acehnese cooking) and common Acehnese dishes are still prepared in homes including *kuah boh panah, asam keueung, kuah ie ôn mulieng, keumamah, kuah pliek, sie balu, payéh* and *keurabu Acèh.* The gravy *kuah boh panah*, *kuah pliek* and the special sticky cake *thimpan* are still served in weddings or holiday celebrations. Weddings that are held in the village display both Acehnese and Malay culture. Some families still decorate the wedding dais or platform with traditional Acehnese decoration and the bridal couples sometimes use traditional Acehnese bridal costumes. The Acehnese tradition of *peusijuek* (a process of blessing the bride and groom or other opening/blessing ceremonies) is still maintained by the villagers.

1.4.2 Acehnese Language in Kampung Aceh

It has been reported that Acehnese is still spoken by the Acehnese descents in Kedah (Asmah, 1992; Durie, 1985; Daud & Durie, 2002). As for KpA in particular, the Acehnese descents have retained their culture not just through culinary and religious practice, but also greatly through the language (Azrul, 2012b). Yusuf, Pillai and Mohd. Ali (2013) interviewed 57 Acehnese descents in KpA from the second to the sixth generations individually and some in groups on their language choice at home amongst family members and with the villagers of Acehnese and non-Acehnese descents. The findings imply that Acehnese descents in KpA still regard themselves as Acehnese, and this identity was exhibited through the use of Acehnese among the descents in the village. Their current perception of Acehnese identity, even by the younger generations who spoke less Acehnese, is still strong with members referring to themselves as "Acehnese", *ureueng Acèh* 'Acehnese people' or as *tanyoe keturunan Acèh* 'we are the Acehnese descents' (Yusuf, Pillai, Mohd. Ali, 2013, p. 58).

The Acehnese descents in KpA from the fourth generation claimed that they had only learned Malay when they first started primary school at the age of seven. Most children learnt Acehnese as their first language from birth if both parents were of Acehnese descents. Those who married Malays were likely to mix Acehnese and Malay, particularly the Kedah Malay dialect. If Malays were present in conversations (such as those who have married Acehnese in KpA), Acehnese speakers were likely to switch to Malay.

The Acehnese descents in KpA from the second till the fifth generation said that they could read and write in Acehnese. They said that to read Acehnese was easy as the Acehnese language was written in Romanized characters, but they find writing difficult as they were never educated formally in Acehnese. Acehnese books, songs and movies were available in KAMC (Kampung Aceh Management Center), and some had personal copies brought back from their visits to the province or given to them by family members who visited them from Aceh province.

Yusuf, Pillai and Mohd. Ali (2013) reported that approximately 64.4% of Acehnese descents in KpA still speak Acehnese at home as a dominant language. About 19.2% of them use Acehnese as a dominant language at home but with a mixture of Malay (commonly, the Kedah dialect), whilst 6.7% use Malay dominantly mixed with Acehnese language. Approximately 9.6% use Malay dominantly with their family members. The interviews also revealed that there was a concern from Acehnese descents in KpA about their Acehnese being different from the one spoken in Aceh province.

1.5 Statement of Problem

From the concerns put forward by Acehnese descents in KpA on their Acehnese, the initial auditory observation while communicating with them was that the differences were mainly apparent in their pronunciation features. The differences in the Acehnese spoken in KpA are anticipated given the language contact of Acehnese with Malay and Kedah Malay dialect in KpA over the years. Linguistic changes are bound to take place among varieties that are geographically distributed (O'Grady, Dobrovolsky & Katamba, 1996). The passage of time, exposure and contact with these languages are likely to have influenced and brought changes to the Acehnese spoken in KpA.

Even though outside of Aceh province Acehnese is also spoken, there is a lack of published research on the linguistic characteristics of these variations. Further, nearly all explanations on Acehnese pronunciation are generally derived from impressionistic descriptions (e.g. Al-Harbi, 2003; Asyik, 1987; Durie, 1985; Sulaiman, et al., 1977). Therefore, it is necessary to conduct research on Acehnese pronunciation in the course of instrumental analysis and to compare phonological variation of Acehnese across geographical borders as well. The vowel system is worth examining because it tends to be an area where sound change is most evident (compared to consonants).

Differences in sound systems are usually one of the most obvious differences between varieties of a language. Hence, to begin to address this research gap, this study aims to examine the acoustic features of the Acehnese vowels produced by Acehnese speakers in KpA, in particular the oral vowels, and compare them with the ones used by Acehnese speakers in Aceh in Indonesia (hereafter, Ach). Ancestors of Acehnese descents in KpA came from various regencies in the province of Aceh. It would not be convenient to compare the Acehnese spoken by Acehnese descents in KpA with all of the four dialects since these dialects are mutually intelligible. For example, Asyik

(1987) states that between the Pidie and North Aceh dialects, not much difference is found. Hanafiah and Makam (1984) also state that:

> *Demikian juga dalam bahasa Aceh terdapat juga variasi dialektis, tetapi variasi itu sangat kecil sehingga tidak mengganggu kelancaran dalam berkomunikasi antar penutur bahasa itu.* [In Acehnese there are also dialectal variations, but these variations are very small so it does not disturb the fluency in communication among the speakers of this language.] (Hanafiah & Makam, 1984, p. 3).

Therefore, it is expected that an instrumental study of Acehnese vowels from speakers in Ach and KpA can support the presentation of more systematic vowel descriptions produced in both locations at present.

1.6 Objectives of Study

The objectives of the study are as follows:

1. To examine the characteristics of the oral monophthongs and diphthongs produced by Acehnese speakers in Ach and KpA based on the acoustic properties of the vowels obtained from elicited and spontaneous speech.
2. To compare the vowels by speakers in these two locations based on their acoustic properties.
3. To determine the similarities and differences between the vowels in KpA and that of Standard Malay (hereafter, SM) and Kedah dialect (hereafter, KD).

Acehnese also consists of nasal vowels, which include nasal monophthongs and nasal diphthongs, but only oral vowels were analyzed for this study. Nasals were excluded because the velar position acts as the articulatory factor that signals nasalization, and in acoustic measurement they are “conflated” with other articulatory factors such as the anatomy of speakers and the vowel articulation on which nasalization is affected

(Berger, 2007, p. 3). Therefore, it becomes a problem in acoustic studies. For that reason, nasal vowels require a separate treatment in relation to their phonemic status, and their acoustic properties (Berger, 2007; Chen, 1997; Hawkins & Stevens, 1985) and were not included in this present study.

Even though this study also conducted comparisons between Acehnese vowels in KpA with SM and KD to further see the influences, thus, the focus and main interest of this study are the Acehnese vowels in Ach and KpA.

1.7 Research Questions

Based on the objectives, the research questions that are addressed in this study are as follows:

1. What are the characteristics of the oral monophthongs and diphthongs in the Acehnese language used by speakers in Ach and KpA based on their acoustic properties?
2. What are the similarities and differences between the vowel inventories and characteristics of Acehnese in Ach and KpA based on their acoustic properties?
3. To what extent are the vowels in KpA similar and different to SM and KD?

1.8 Significance of Study

The main incentives for comparing the oral vowel systems of Acehnese used in Ach and KpA are as follows:

(i) To add to the mostly impressionistic studies of Acehnese speech sounds through acoustic investigation of the vowels.

(ii) To systematically document the oral vowel inventory of Acehnese outside of Indonesia, specifically Kedah, Malaysia, thus, adding to the currently sparse information on this aspect.

(iii) To fill the research gap on the acoustic properties of Acehnese oral vowels in Ach and KpA, and provide a starting point for further research into other varieties of Acehnese.

(iv) To contribute to knowledge about language change by examining Acehnese speech sounds spoken in KpA.

Apart from the motivation listed above, this study also intends to contribute to the conservation and documentation of Acehnese within and outside of the province. The earthquake and tsunami on December 26, 2004 destroyed much of the documents and materials kept in Aceh Documentation and Information Center (*Pusat Dokumentasi Aceh*), and Aceh Cultural Foundation (*Lembaga Kebudayan Aceh*). Therefore, it is hoped that this research can contribute to our understanding of Acehnese phonology and serve as a starting point for further research.

1.9 Thesis Organization

This thesis is organized into eight chapters.

Chapter One presents the background of study, including the Acehnese language spoken in Ach and the presence of Acehnese in Malaysia, the setting up of KpA in Kedah, the statement of problem, the objectives of study, research questions and the significance of this research.

Chapter Two presents previous studies on the Acehnese oral vowels and the vowels in Standard Malay (SM) and Kedah dialect (KD). It also discusses the acoustic characteristics of vowels and reviews methodologies used in acoustics studies. Additionally, a review that deals with language contact and change is also presented to explain the Acehnese sound maintenance and change by Acehnese descents in KpA as a minority language spoken in the Malay domain.

Chapter Three describes the methodology employed in the data collection and analysis of oral vowels. This includes the profiles of language consultants (from Ach and KpA, and those of SM and KD speakers), the process of data collection (venues and instrumentation) and the analyses carried for the monophthong and diphthong measurements.

The findings of Acehnese vowels in this study are presented in Chapters Four and Five. Chapter Four discusses the findings for monophthongs based on data from word elicitation (WE) and interview (INT). Chapter Five provides the findings for diphthongs from WE and INT. Furthermore, Chapter Six provides the findings from SM and KD oral vowels. Comparisons between the acoustic characteristics of Acehnese vowels in Ach and KpA are presented.

Chapter Seven discusses the findings from Chapter Four to Chapter Six. Lastly, Chapter Eight presents the conclusion of this study. It also presents the limitations of study and suggestions for future research.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter discusses previous studies on Acehnese oral vowels, Standard Malay and Kedah dialect vowels. It also examines the acoustic characteristics of vowels and reviews methodologies used in acoustics studies. Lastly, it reviews theories in language contact, language and identity, and motivations for sound change.

2.2 Studies on Acehnese

A book on the grammar and a dictionary on Acehnese by van Langen in 1889 was the first publication on Acehnese language (Asyik, 1987). It was written in Arabic script or *Arab Jawi* (Malay written in Arabic script). Although the discussion on grammar and phonology had several weaknesses (Durie, 1985), information on the basic linguistic aspects of the language is provided in the book. Afterwards, Hurgronje (1892, 1906, as cited in Asyik 1987) who carried out numerous researches on the people of Aceh, particularly on their culture, transliterated Acehnese in Latin orthography to make it more available to those who could not read the Arabic script. Kreemer (1931, as cited in Asyik, 1987) and Djajadiningrat (1934, as cited in Asyik, 1987) also adopted his work as the basis for their Acehnese dictionaries.

Nevertheless, Acehnese linguists who have carried out studies on Acehnese language and published their work as textbooks have mostly highlighted their research on the structure of the language (e.g. Ishak, 1968; Sulaiman, 1978). There is a dearth of work focusing on its sound system. Descriptions of Acehnese sounds are mainly based on impressionistic analysis, such as those by Al-Harbi (2003), Asyik (1987), Durie (1985) and Sulaiman, et al. (1977). These are discussed in 2.3.

2.3 Acehnese Vowels

Hurgronje (1893, as cited in Durie, 1990) first described the Acehnese vowel system as consisting of three front vowels of /i/, /e/, /ɛ/, three back unrounded vowels of /ɯ/, /ɵ/, /a/ and three back vowels of /u/, /o/, /ɔ/. This inventory was based on his data from speakers in the lowlands of the Greater Aceh dialect in Banda Aceh region.

Proyek Pelita (a Five-Year Development Plan Project) from the government funded a series of studies conducted from 1976 to 1980 on Acehnese language by a team that was led by Sulaiman from the Faculty of Education of Universitas Syiah Kuala in collaboration with a number of research projects carried out by Universitas Syiah Kuala and IAIN Ar-Raniry (an Islamic institute). A compilation of report was put together for *Pusat Pembinaan dan Pengembangan Bahasa* (Center for Language Management and Development) under the Department of Education and Culture. From this work, Asyik (1972) and Sulaiman, et al. (1977), who based their data on North Aceh dialect speakers, described the contrast between /ʌ/ and /ɔ/. The data for this research report were collected from ten Acehnese residing in the sub-district of Peusangan who was all speakers of the North Aceh dialect living in the cities and villages and classified based on age, origin, gender, education and social status (Sulaiman, et al., 1977). This dialect was selected because it is regarded as the form of standard Acehnese by Acehnese linguists as informed in Asyik (1987), Durie (1985), Hanafiah and Makam (1984) and Sulaiman (1983). Acehnese phonology based on impressionistic analysis is briefly explained and presented in the research report by Sulaiman, et al. (1977). Nonetheless, it does not provide any charts for the Acehnese sounds and they are simply presented in lists of vowels and consonants following some examples of words including these sounds. From Sulaiman, et al. (1977: v-vi), a number of thirty Acehnese oral and nasal vowels are listed (the IPA symbols here that are presented differently from Asyik (1987) is discussed in 2.3.1):

- nine oral vowels: /i/, /e/, /c/, /a/, /ə/, /o/, /ɛ/, /ɔ/, /ᴖ/ and /u/
- six oral nasals: /ĩ/, /ɛ̃/, /ã/, /õ/, /c̃/ and /ũ/
- ten diphthongs: /ay/, /ɛə/, /iə/, /cə/, /oy/, /uə/, /uy/ and /əy/
- five nasal diphthongs: /ãy/, /ɛ̃ə/, /ĩə/, /ũə/ and /c̃ə/

Sulaiman (1978, 1979), Effendi, Muhadjir and Sugono (1979) and Sulaiman, et al. (1983) later published textbooks on Acehnese structure for public and boarding schools that were based on the research report by Sulaiman, et al. (1977). Hanafiah and Makam (1984) also compiled a book on the structure of Acehnese language. There is also a section on Acehnese phonology in its second chapter and its description is similar to Sulaiman, et al. (1977) with thirty oral and nasal vowels altogether. However, the study does not state the dialect of Acehnese speakers being investigated and the number of informants.

Durie's (1985) work on Acehnese grammar based on the North Aceh dialect from speakers residing in Bireuen provided a description of twenty seven Acehnese vowels that consisted of oral and nasal monophthongs and diphthongs as shown in Figure 2.1.

oral:			
high	i	ɯ	u
high-mid	e	ɤ	o
low-mid	ɛ	ʌ	ɔ
low		a	
nasal:			
high	ĩ	ɯ̃	ũ
mid	ɛ̃	ʌ̃	ɔ̃
low		ã	

Figure 2.1: Acehnese oral and nasal monophthongs from Durie (1985)
(reproduced from Durie, 1985, p. 16)

However, the spacing in Figure 2.1 was “not intended to be an indication of vowel quality” (Durie, 1985, p. 15). Durie explains that Acehnese rounded vowels are produced with only very little lip rounding and the lips are not far shifted from the rest position. The unrounded back vowels of /ɯ/, /ɤ/ and /ʌ/ are seen to be positioned rather centrally and Durie describes them as “backed central vowels” (Durie, 1985, p. 16). He notes that the Acehnese recognize their back unrounded vowels with the front rounded vowels of European languages, for example: the Acehnese /ʌ/ with German *ö*. He states that “both vowels are from the ventrally localised class in their respective languages – but it cannot be accounted for in terms of the traditional articulation based-unrounded and front-central-back contrasts” (Durie, 1985, p. 17).

If we look back at Hurgronje's (1893) inventory, it does not consist of /ʌ/, and what Durie describes as /ɤ/ is described as /ɵ/ by Hurgronje. This is because both data sets were from different Acehnese dialects that vary from dialect to dialect in their degree of backness (Durie, 1990). Durie (1987) notes that the Greater Aceh dialect merged /ʌ/ into /ɔ/ and Asyik (1987) also says that /ʌ/ is not distinguished from /ɔ/ in some areas of this dialect, especially Banda Aceh and Ulee Lheue.

From a recording of one male speaker from Calue in the Pidie district, Durie (1985) further plotted the ten oral monophthongs. This finding should be treated cautiously given that it was based on only one speaker. Figure 2.2 is the formant plot of Acehnese oral monophthongs of /i/, /e/, /ɛ/, /ɯ/, /ɤ/, /ʌ/, /a/, /u/, /o/ and /ɔ/ based on the recording (Durie, 1985, p. 18):

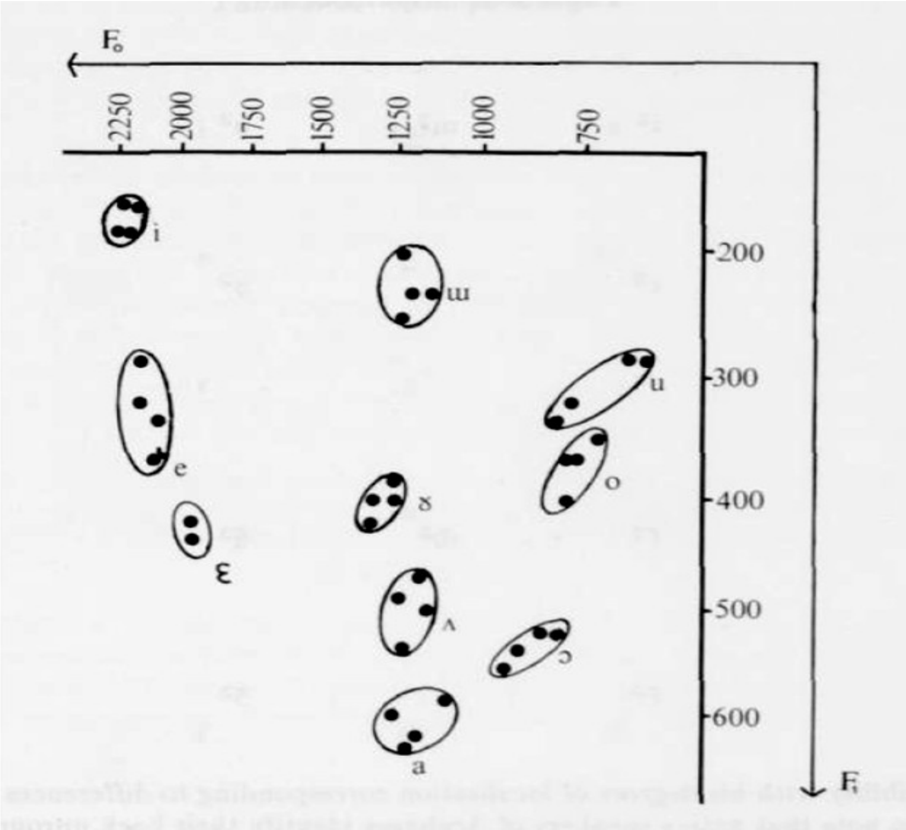


Figure 2.2: A formant chart of Acehnese oral vowels from Durie (1985)
(source: Durie, 1985, p. 18)

Figure 2.22.2 shows that there is no central /ə/ vowel in Acehnese, although Durie mentions that in unstressed syllables, /ɯ/ is realized closer to [ə], for example: *rheut* [rhɯt] 'braid' (stressed) and *rhet* [rhət] (unstressed). No explanations about how the sounds were obtained from the speaker were provided. Neither was information about how the vowels were measured and analyzed. Unlike Asyik (1987) and Sulaiman, et al. (1977), Durie does not include oral and nasal diphthongs ending with /i/ in his inventory of Acehnese vowels, as shown in Figure 2.3.

oral:			
high	iə	ɯə	uə
mid	ɛə		ɔə
nasal:			
high	ĩə	ɯ̃ə	ũə
mid	ɛ̃ə		ɔ̃ə

Figure 2.3: Acehnese oral and nasal diphthongs from Durie (1985)
(reproduced from Durie, 1985, p. 17)

A study on the onset clusters and sonority sequencing principle in Acehnese was carried out by Al-Harbi (2003). He also discussed the Acehnese vowels in correspondence to Durie's description (1985). Al-Harbi's data were obtained from three speakers of the Pidie dialect who, at the time of his study, were students attending universities in Madina, Jeddah and Mecca. For the oral vowels, he reports that the back vowel /ʌ/ is produced closer to [ɔ] rather than centrally as described by Asyik (1987) and Durie (1985). Further, /ɯ/, which is present in the previous studies, is described as [ɨ]. Perhaps this is because his speakers spoke the Pidie dialect instead of the North Aceh dialect as described by previous studies and he had used the Optimality Theory account to describe the vowels. Asyik (1987), however, does claim the production of /ɯ/ in the Pidie dialect when he explained one of the markers of this dialect compared to others. He says, "Pidie dialect replaces what is [u] in other dialects into [ɯ] (written eu) and what is [ɯ] in other dialects into [u] when these vowels are in the first syllable of a two or three syllable word" (p. 5). Furthermore, the nasals and diphthongs are described by Al-Harbi (2003) similar to Durie's (1985), completely ignoring the rising diphthongs.

It is unclear why Al-Harbi (2003) and Durie (1985) overlooked the rising diphthongs in Acehnese as mentioned by Asyik (1972, 1987) and Sulaiman, et al. (1977) although these diphthongs are common in Acehnese, for example: in words such as *rhôi* [rh**oi**] 'ruler', *dhôi* [dh**oi**] 'ash, crumbs', *apui* [ap**ui**] 'fire', *reului* [rɯl**ui**] 'cool, shady', *akai* [ak**ai**] 'mind', *sapai* [sap**ai**] 'arm', *bangai* [baŋ**ai**] 'foolish, stupid', and *meuh'ai* [mɯh**ãĩ**] 'expensive'. These four rising diphthongs (/oi/, /ui/, /ai/ and /ãi/) appear in a number of other Acehnese words.

As for /əi/, /ɔi/, and /ʌi/, they appear only in very small number of words. The sound /əi/ is only found in the word *hei* [həi] 'to call'. Word examples for /əi/ in previous studies also referred to only *hei* (see Asyik, 1972, p. 25, 1987, p. 25; Hanafiah & Makam, 1984, p. 12; Sulaiman, 1979, p. 6; Wildan, 2002, p. 12). *Hei* is still commonly used by the Acehnese today and this can be seen in INT (see 5.3.3.8) from this present study where all instances of words with the meaning of 'to call' used by Ach language consultants were realized as [həi].

The sound /ɔi/ is found in only two words in the North Aceh dialect, which are *poih* 'mail, post' (borrowed word from Bahasa Indonesia, *pos*, with similar meanings) and *boinah* 'belongings, property, heritage' (see Asyik, 1972, p. 25, 1987, p. 25; Daud & Durie, 2000, p. 75; Hanafiah & Adam, 2000, p. 23; Wildan 2002, p. 12). Due to its limited use in Acehnese words, this may be why the diphthong /ɔi/ does not appear in the Acehnese vowel inventory by Sulaiman, et al. (1977).

As for the sound /ʌi/, it only appears in the word *lagöina* [lagʌina] ‘very’. Word examples for /ʌi/ from previous studies also referred to *lagöina* (see Asyik, 1972, p. 25, 1987, p. 25; Wildan, 2002, p. 12). However, the Acehnese does not frequently use this word today. The sound was also not provided in the Acehnese inventory by Sulaiman, et al. (1977) nor was it found in the dictionary entry by Hanafiah and Adam (2000). Nevertheless, it is still maintained by the people as it appears in a notable Acehnese traditional song *Bungong Jeumpa* ‘Magnolia Champaca Flower’, that is commonly sung in ceremonies such as weddings, the opening of events, harvest seasons, children’s games and so forth. An excerpt of the song is as follows (taken from http://yayasanmusikpelanginusa.blogspot.com/2011/11/lirik-lagu-bungong-jeumpa-dari-di-aceh.html):

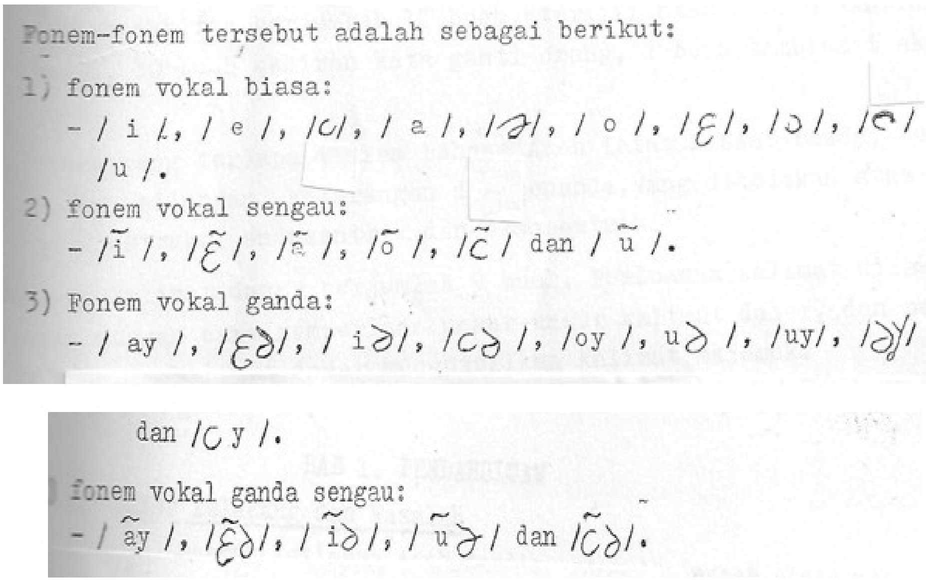
> *Bungong jeumpa, bungong jeumpa, meugah di Acèh*
> *Bungong teuleubèh-teuleubèh, indah* ***lagöina***
> *Bungong jeumpa, bungong jeumpa, meugah di Acèh*
> *Bungong teuleubèh-teuleubèh, indah* ***lagöina***
>
> > *Putéh kunèng, meujampu mirah*
> > *Bungong si ulah, indah* ***lagöina***
> > *Putéh kunèng, meujampu mirah*
> > *Bungong si ulah indah* ***lagöina***

Presumably, from the limited use of *lagöina* in the present Acehnese, and with the representation of /əi/ and /ɔi/ in only a few words, most of the rising diphthongs are absent in studies by Al-Harbi (2003), and Durie (1985) and Sulaiman, et al. (1977).

2.3.1 Asyik's Vowel Inventory

Whilst studies by Al-Harbi (2003), Durie (1985) and Sulaiman, et al. (1977) have all described the Acehnese vowels, to date, the most comprehensive description of these vowels are presented in Asyik's vowel inventory. An inclusive study on Acehnese phonology was presented by Asyik (1972) for his Master's thesis, *Atjehnese Morphology*, which focused on the morphology of Acehnese but a section was also contributed to the phonology. Asyik's doctoral dissertation in 1987, *A Contextual Grammar of Acehnese*, which mainly focused on Acehnese grammar, also briefly presented a section for the descriptions of its vowels. The data for both of these theses were obtained from recordings of North Aceh dialect speakers, although the number of speakers is not stated. The method used to describe the vowels and consonants were based on impressionistic analysis. His work firstly introduced the diphthongs /ʌi/, /ʌə/, /ɔi/, and nasal /ʌ̃/ in Acehnese. These four sounds were not mentioned in previous studies even though their data were also obtained from speakers of the North Aceh dialect. It is not sure why this is so. The IPA symbols provided by Sulaiman, et al. (1977) (see Figure 2.4) are presented differently from Asyik's. For example, the differences in monophthongs lay in the representation of /ɯ/, which was presented as /c/ by Sulaiman, et al. (1977). The example of words provided are ***eu**ntat* 'to send', *an**eu**k* 'child' and *k**eu*** 'to' (p. 6), which is clearly described as /ɯ/ by Asyik (1972, 1987) and Durie (1985). There is also /ʌ/ that was presented as /ɒ/ by Sulaiman, et al. (1977, p. v).

Again, the word examples provided by Sulaiman, et al. (1977, p. 6) for this sound are *bӧh* ‘to throw away’ and *deungӧ* ‘hear’, symbolized as /ʌ/ by Asyik (1972, 1987) and Durie (1985). Perhaps the different phonetic symbols used for monophthongs and diphthongs by these studies have caused the number of vowels to be different. Sulaiman, et al. (1977) listed 30 vowels altogether, whereas Asyik’s (1972, 1987) vowel inventory consisted of 34 Acehnese vowels.



Fonem-fonem tersebut adalah sebagai berikut:

1) fonem vokal biasa:
- / i /, / e /, /C/, / a /, /ə/, / o /, /ɛ/, /ɔ/, /ə̑/ /u /.

2) fonem vokal sengau:
- /ĩ /, /ɛ̃/, /ã /, /õ /, /C̃/ dan / ũ /.

3) Fonem vokal ganda:
- / ay /, /ɛə/, / iə/, /Cə /, /oy /, uə /, /uy/, /əy/ dan /Cy /.

fonem vokal ganda sengau:
- / ãy /, /ɛ̃ə/, / ĩə /, / ũə/ dan /C̃ə/.

Figure 2.4: Acehnese vowels from Sulaiman, et al. (1977)
(source: Sulaiman, et al., 1977, pp. v-vi)

Textbooks today that are utilized to teach the Acehnese language to junior high school students in Aceh province also adopt Asyik’s vowel inventory, which is based on the North Aceh dialect (Wildan, 2002; Abdullah, Faridan, Harun, Syafi’i, Hanum, Badruddin & Husni, 2008; Abdullah, Faridan, Syafi’i, Hanum, Badruddin & Husni, 2010). Similarly, for this study, Asyik’s vowel inventory is also used as a basis to study the vowels.

2.3.1.1 Acehnese Monophthongs

Asyik (1987) describes Acehnese as having ten oral monophthongs. As presented in Table 2.1, the oral vowels are high /i/, /ɯ/, /u/, mid-high /e/, /ə/, /o/, mid-low /ɛ/, /ʌ/, /ɔ/ and low /a/.

Table 2.1: Oral Monophthong Vowels in Acehnese
(reproduced from Asyik, 1987, p. 17)

High	i	ɯ	u
Mid-High	e	ə	o
Mid-Low	ɛ	ʌ	ɔ
Low		a	

To demonstrate that the ten oral monophthongs constitute of separate phonemes in Acehnese, Table 2.2 provides examples of minimal pairs for oral monophthongs. Those pairs that are provided with two examples each indicate that they have more common alternatives in other words, thus, those with only one example each specify cases where there are only one illustration for those pairs (such as /ɛ/ - /ə/ and /ə/ - /ɔ/). The word samples are from the North Aceh dialect.

Table 2.2: Examples of Minimal Pairs for Oral Monophthongs
(some examples (indicated with **) are reproduced from Pillai & Yusuf, 2012, p. 1045)

Vowels	Examples
/i/ - /e/	*bit* [bit] ‘serious’ - *bét* [bet] ‘mock, tease’** *dik* [dik] ‘breast’ - *dék* [dek] ‘younger sibling’
/i/ - /ɯ/	*tika* [tika] ‘straw mat’ - *teuka* [tɯka] ‘attend, come’** *ci* [tʃi] ‘try’ – *ceu* [tʃɯ] ‘scribble’
/i/ - /ə/	*cit* [tʃit] ‘too, also’ - *cet* [tʃət] ‘yank, catch, grab’ (variation from *chet*)** *dhit* [dhit] ‘a small amount’ – *dhet* [dhət] ‘scold’
/e/ - /ɛ/	*kéh* [keh] ‘pocket’ - *kèh* [kɛh] ‘lighter’** *éh* [eh] ‘sleep’ – *èh* [ɛh] ‘ice’

‘Table 2.2, continued’

/e/ - /ɯ/	*pét* [pet] ‘close/shut the eyes’ - *peut* [pɯt] ‘four’** *kéh* [keh] ‘pocket’ - *keuh* [kɯh] ‘so (e.g. nyan *keuh*), pronominal affix for second person (e.g. *droe-keuh*)’
/e/ - /ə/	*lét* [let] ‘hunt, chase, run after’ - *let* [lət] ‘pull out’** *bét* [tet] ‘(to) mock’ – *bet* [tət] ‘(to) pull out)
/e/ - /ʌ/	*lét* [let] ‘hunt, chase, run after’ - *löt* [lʌt] ‘fit’** *pét* [pet] ‘close/shut the eyes’ - *pöt* [pʌt] ‘pluck, pick’
/ɛ/ - /ə/*	*cèt* [tʃɛt] ‘paint’ - *cet* [tʃət] ‘yank, catch, grab’ (variation from *chet*)**
/ɛ/ - /ʌ/	*cèt* [tʃɛt] ‘paint’ - *cöt* [tʃʌt] ‘vertical, hill’** *tèh* [tɛh] ‘tea’ - *töh* [tʌh] ‘which (one)’
/ɛ/ - /a/	*bèk* [bɛk] ‘no’ - *bak* [bak] ‘at, tree’** *tèk* [tɛk] ‘cut’ - *tak* [tak] ‘slash, chop off’
/ɯ/ - /ə/	*rheut* [rhɯt] ‘braid’ - *rhet* [rhət] ‘fall’** *dheut* [dhɯt] ‘a type of fish’ - *dhet* [dhət] ‘scold’
/ɯ/ - /u/	*keuh* [kɯh] ‘so (e.g. nyan *keuh*), pronominal affix for second person (e.g. *droe-keuh*)’ - *kuh* [kuh] ‘myself (impolite)’** *beu* [bɯ] ‘to (make of something)’ – *bu* [bu] ‘rice, meal’
/ɯ/ - /o/	*peut* [pɯt] ‘four’ - *pot* [pɔt] ‘flower pot, vase’** *seuk* [sɯk] ‘scoot’ – *sok* [sɔk] ‘arrogant’
/ə/ - /ʌ/	*cet* [tʃət] ‘yank, catch, grab’ (variation from chet) - *cöt* [tʃʌt] ‘vertical, hill’** *beh* [bəh] ‘expression of agreement, okay’ – *böh* [bʌh] ‘discard, throw away’
/ə/ - /u/	*cet* [tʃət] ‘yank, catch, grab’ (variation from chet) - *cut* [tʃut] ‘small, title for women of noble descent’** *tet* [tət] ‘burn’ - *tut* [tut] ‘anything’
/ə/ - /o/	*beh* [bəh] ‘expression of agreement, okay’ - *bôh* [boh] ‘insert, put’** *bet* [bət] ‘(to) pull out’ – *bôt* [bot] ‘boat’
/ə/ - /ɔ/*	*beh* [bəh] ‘expression of agreement, okay’ - *boh* [bɔh] ‘fruit’**
/ʌ/ - /a/	*pöt* [pʌt] ‘pluck, pick’ - *pat* [pat] ‘where’** *töh* [tʌh] ‘which (one)’ - *tah* [tah] ‘bag’
/ʌ/ - /o/	*pöt* [pʌt] ‘pluck, pick’ - *pôt* [pot] ‘blow, to fan’** *töh* [tʌh] ‘which (one)’ - *tôh* [toh] ‘fall’
/ʌ/ - /ɔ/	*pöt* [pʌt] ‘pluck, pick’ - *pot* [pɔt] ‘flower pot, vase’** *böh* [bʌh] ‘discard, throw away’ – *boh* [bɔh] ‘fruit’
/u/ - /o/	*tutu* [tutu] ‘bridge’ - *tutô* [tuto] ‘speak’** *bahu* [bahu] ‘bring’ - *bahô* [baho] ‘shoulder’
/o/ - /ɔ/	*tôp* [top] ‘close, cover, shut’ - *top* [tɔp] ‘stab, spear’** *batôk* [batok] ‘cough’ - *batok* [batɔk] ‘shell’

‘Table 2.2, continued’

/ɔ/ - /a/	*koh* [kɔh] ‘cut’ – *kah* [kah] ‘you (impolite)’** *boh* [bɔh] ‘fruit’ – *bah* [bah] ‘let’

n.b. *cases where there is only one illustration for this pair.

Asyik (1987) also presents seven nasal monophthong vowels in his inventory. The phonemic inventory for monophthong vowels provided by Sulaiman, et al. (1977, pp. v-vi) is also similar to Asyik’s but does not contain /ʌ̃/ although their study is also based on North Aceh dialect speakers. The nasal monophthongs are similar to the oral ones except that there are no mid-high nasal vowels. Table 2.3 presents the nasal monophthong vowels: high /ĩ/, /ɯ̃/, /ũ/, low-mid /ɛ̃/, /ʌ̃/, /ɔ̃/ and low /ã/.

Table 2.3: Nasal Monophthong Vowels in Acehnese
(reproduced from Asyik, 1987, p. 17)

High	ĩ	ɯ̃	ũ
Mid-Low	ɛ̃	ʌ̃	ɔ̃
Low		ã	

In relation to syllable position, even though vowels can occur after consonants in Acehnese, nasal vowels tend not to be preceded by voiced oral obstruent except in the case of onomatopoeic sounds (e.g. [dãŋ dĩŋ] and [bɛ̃h]) and in /Cr/ and /Cl/ sequences (e.g. [mãndrɛ̃t] ‘a type of spicy drink’) (Durie, 1985). Durie (1987, p. 142) also states that an oral consonant and nasal vowel sequence (CVC) and a nasal consonant and oral vowel sequence (NV) do not occur in unstressed syllables. Further, the nasal vowels are said to only occur in unstressed syllables when they are preceded by a nasal stop (Durie, 1985, p. 21). The phonemic status of nasal vowels in Acehnese and the influence of an effect on the preceding nasal consonant continues to be discussed (e.g. Ladefoged &

Maddieson, 1996; Stokhof, 1992), but since the focus of this study is on oral vowels, the issues surrounding nasal vowels in Acehnese is not pursued in this chapter.

2.3.1.2 Acehnese Diphthongs

Asyik (1987, pp. 17-18) describes 12 oral diphthongs for Acehnese, which are categorized into two sets:

- diphthongs ending with /ə/ (with a central offglide)
- diphthongs ending with /i/ (with a rising offglide)

The additional diphthongs he included that are not found in the list of vowels by Sulaiman, et al. (1977) are /ʌə/, /ʌi/ and /ɔi/.

Table 2.44 presents the Acehnese oral diphthongs ending with /ə/ and Table 2.5 shows the Acehnese oral diphthongs ending with /i/.

Table 2.4: Acehnese Oral Diphthongs Ending with /ə/
(reproduced from Asyik, 1987, p. 18)

/iə/	/ɯə/	/uə/
/ɛə/	/ʌə/	/ɔə/

Table 2.5: Acehnese Oral Diphthongs Ending with /i/
(reproduced from Asyik, 1987, p. 18)

	/ui/
/əi/	/oi/
/ʌi/	/ɔi/
/ai/	

While the oral monophthongs in Acehnese can occur in both closed and open syllables, this is not true for all of the oral diphthongs. In the North Aceh dialect, for example, /ɛə/ and /ɔə/ (see Durie, 1985, p. 21) as well as /əi/, /ui/, /ʌi/, /oi/, /ai/ and /ʌə/ can typically only occur in open syllables. This is illustrated in Table 2.6 where the examples for diphthongs /ɛə/, /ʌə/, /ɔə/, /əi/, /ui/, /ʌi/, /oi/ and /ai/ are only provided in the column for open syllables. Besides diphthongs, Table 2.6 also provides examples for monophthongs in open and closed syllables. The word samples are from the North Aceh dialect.

Table 2.6: Acehnese Vowels in Open and Closed Syllables
(reproduced from Pillai and Yusuf, 2012, p. 1032)

Vowel	Open	Closed
/i/	*di* [di] 'in, from'	*dit* [dit] 'few, small amount'
/e/	*baté* [bate] 'cup, betel tray'	*baték* [batek] 'batik'
/ɛ/	*krè* [krɛ] 'scrawny'	*krèk* [krɛk] 'piece'
/ɯ/	*keu* [kɯ] 'front'	*keuh* [kɯh] 'so (e.g. nyan *keuh*), pronominal affix for second person (e.g. *droe-keuh*)'
/ə/	*le* [lə] 'many'	*let* [lət] 'pull out'
/ʌ/	*pö* [pʌ] 'fly'	*pöt* [pʌt] 'pluck, pick'
/a/	*ba* [ba] 'carry'	*bak* [bak] 'at, tree'
/u/	*su* [su] 'sound, voice'	*sut* [sut] 'open, undress'
/o/	*rô* [ro] 'spill'	*rôh* [roh] 'enter'
/ɔ/	*yo* [jɔ] 'afraid'	*yok* [jɔk] 'shake'
/iə/	*wie* [wiə] 'left'	*wiet* [wiət] 'break'
/ɯə/	*jeue* [ʤɯə] 'netting'	*jeuet* [ʤɯət] 'become, may, can'
/uə/	*hue* [huə] 'pull'	*huek* [huək] 'choke'
*/ɛə/	*adèe* [adɛə] 'to dry'	-
*/ʌə/	*lagöe* [lagʌə] 'particle for surprise'	-
*/ɔə/	*bajoe* [baʤɔə] 'dowel, pin, peg'	-
*/əi/	*hei* [həi] 'to call'	-

'Table 2.6, continued'

*/ui/	*apui* [apui] 'fire'	-
*/ʌi/	*lagöina* [lagʌina] 'very'	-
*/oi/	*dhôi* [dhoi] 'ash'	-
/ɔi/	*boi* [bɔi] 'nickname from the name Boihaqi'	*boinah* [bɔinah] 'property'
*/ai/	*sapai* [sapai] 'arm'	-

n.b. *only occurs in open syllables.

Asyik's inventory also comprises four nasal diphthongs ending with /ə/ (/ĩə/, /ɯ̃ə/, /ũə/ and /ɛ̃ə/) and one ending with /i/ (/ãi/). In the descriptions by Asyik (1972, 1987) and others (e.g. Al-Harbi, 2003; Durie, 1985; Sulaiman, et al., 1977; Wildan, 2002), the oral and nasal vowels are presented as separate phonemes. Table 2.7 illustrates the examples of Acehnese minimal pairs in nasal and non-nasal vowels, showing them to be separate phonemes. The word samples are from the North Aceh dialect.

Table 2.7: Examples of Acehnese Minimal Pairs – Nasal and Non-nasal Vowels (reproduced from Asyik, 1972, pp. 15-16)

Oral vowels	Nasal Vowels
ci [tʃi] 'to try'	*c'i* [tʃĩ] 'the imitation of a sound'
tèm [tɛm] 'to spend thriftily'	*t'èm* [tɛ̃m] 'tin can'
eu [ɯ] 'to see'	*'eu* [ɯ̃] 'yes'
cöt [tʃʌt] 'vertical, hill'	*c'öt* [tʃʌ̃t] 'to click the tongue'
crah [tʃrah] 'splitting'	*cr'ah* [tʃrãh] 'to fry with some spice'
u [u] 'coconut'	*'u* [ũ] 'a humming sound'
prok [prɔʔ] 'to claps one's hands, pock-marks'	*pr'ok* [prɔ̃ʔ] 'to discharge'

In summary, published work on Acehnese vowels that are described through auditory descriptions are those carried out by Hurgronje (1893, as cited in Durie, 1990), Sulaiman, et al. (1977), Asyik (1972, 1987), Durie (1985) and Al-Harbi (2003). From these studies, Sulaiman, et al. (1977), Asyik (1972, 1987) and Durie (1985) describe Acehnese vowels that focus on the North Aceh dialect (see Appendix A for a complete list of their inventory); whilst Hurgronje's and Al-Harbi's descriptions are based on speakers of Greater Aceh and Pidie dialects, which are not the focus of the present study.

Based on previous studies, the vowel inventories posited for Acehnese vary across the different sources. Perhaps this is due to the small number of informants in these studies, the different contexts used to elicit the sounds that essentially affects their use and choice of words, and because the studies were mainly based on auditory impressions. However, most Acehnese commonly accepts Asyik's vowel inventory as it provides the most complete descriptions of Acehnese vowels compared to other studies. As mentioned earlier, Acehnese language textbooks used today for public and traditional boarding schools, such as by Wildan, Faridan, Djunaidi and Sa'adiah (1999), Wildan (2002), Abdullah, et al. (2008) and Abdullah, et al. (2010), all adopt Asyik's work. It is also used as a foundation for the English-Indonesian-Acehnese Dictionary by Hanafiah and Adam (2000) and compilation of the first Acehnese-Indonesian-English Thesaurus (see Daud and Durie, 2002).

2.4 Standard Malay and Kedah Dialect Vowels

This section discusses the vowels of SM and KD as the current study looks at the possible influences of SM and KD on Acehnese vowels produced by speakers in KpA.

2.4.1 Standard Malay Vowels

Malaysia declared its independence from British colonization on 31 August 1957, whilst Indonesia had earlier declared its independence on 17 August 1945. In 1959, Indonesia and Malaysia signed an agreement to standardise the Malay spelling system of both countries (Rozan, 2010). This was due to the influence of different colonial languages; Dutch in the case of Indonesia and English in the case of Malaysia, and also Singapore and Brunei (that were also formerly under British rule). Malay becomes the national language of Malaysia, Indonesia, Brunei (claimed in the signing of Brunei 1959 Constitution) and Singapore, where it is also one of the four official languages (chosen by the Singaporean government after independence from Britain in the 1960s). In Indonesia, the Malay language is now called Bahasa Indonesia, and in Malaysia, the Malay language is officially called Bahasa Malaysia. Apart from the four countries, Malay speaking communities are also found in Thailand, Sri Lanka, Australia, Cambodia and South Africa (Collins, 1998).

In Malaysia, Malay as the national language is portrayed by the existence of various regional and social dialects (Asmah, 1977). Asmah (1993) states that the Malay language in Malaysia is characterised by a variety of dialects, namely Johor, Selangor, Melaka, Sarawak, Kedah, Perak, Pahang, Kelantan, Terengganu, Negeri Sembilan, Urak Lawoi', Brunei and Kedayan. Asmah (1977) further says that the standard of this language is a variety accepted by all members of the speech community to be the norm used for formal and official communication and as the medium of education. It is conventionally believed that the dialect spoken in southern part of Malay Peninsula, which is the Johor dialect, is the standard dialect of Malay (Tajul, 2000; Teoh, 1994). It has been chosen as the national language of Malaysia because of its extensive known role as the medium between different ethnic groups of Malaysia (Tajul, 2000).
This following section discusses the vowels of SM.

2.4.1.1 Standard Malay Monophthongs

SM has six monophthongs vowels, which are /i/, /e/, /ə/, /a/, /u/ and /o/ (Asmah, 1993; Chaiyanara, 2001; Indirawati & Mardian, 2006; Teoh, 1994; Yunus, 1980). All of these vowels can occur at all positions of the syllable (initial, medial, final) (Asmah, 1993). Table 2.88 shows the inventory of SM oral monophthongs.

Table 2.8: The Standard Malay Vowel Inventory
(reproduced from Teoh, 1994, p. 7)

i		u
e	ə	o
	a	

The front and central vowels are usually unrounded, while the back vowels are rounded with slight lip rounding (Yunus, 1980). Malay has no vowel length contrast. Regarding this, Yunus (1980, p. 9) says that vowel length 'has no semantic bearing in Malay'. Table 2.9 presents some examples of minimal pairs for SM monophthongs. The examples are reproduced and translated from Indirawati and Mardian (2006). They show that the monophthongs are represented in different phonemes in SM.

Table 2.9: Examples of Minimal Pairs for SM Monophthongs
(reproduced from Indirawati & Mardian, 2006, pp. 145-146)

Vowels	Examples
/i/ - /e/	*bila* [bila] 'when' - *bela* [bela] 'defend'
/e/ - /a/	*bela* [bela] 'defend'- *bala* [bala] 'disaster'
/i/ - /a/	*bila* [bila] 'when' - *bala* [bala] 'disaster'
/o/ - /u/	*burung* [buruŋ] 'bird' - *borong* [boroŋ] 'wholesale'
/ə/ - /i/	*beri* [bəri] 'give' - *biri* [biri] 'sheep'
/ə/ - /e/	*bela* [bəla] 'preserve' - *bela* [bela] 'defend'
/ə/ - /a/	*entah* [əntah] 'unknown' – *antah* [antah] 'remainings in the rice paddy'
/ə/ - /o/	*bela* [bəla] 'preserve' - *bola* [bola] 'ball'
/ə/ - /u/	*sekat* [səkat] 'barrier' - *sukat* [sukat] 'measure'

An acoustic study on Malay was conducted by Mardian (2005), which presented spectrographic differences between vowels and consonants. The study presents the F1 and F2 values in Hertz of Malay vowels collected from one Malay speaker. Table 2.10 shows the F1 and F2 values of Malay vowels from Mardian (2005).

Table 2.10: F1 and F2 Values (Hz) of Malay Vowels
(reproduced from Mardian, 2005, p. 5)

Formants	i	e	a	o	u	ə
F1	290	685	740	470	455	680
F2	2220	1970	1692	900	1333	1630
F2 – F1	1930	1285	952	430	878	950

However, the study does not describe how the sounds were extracted or whether the speaker was a male or female or where the speaker was from. However, it is assumed that the vowels are representative of SM because the aim of the study was to differentiate the production of Malay vowels and consonants based on spectrographic analysis. A vowel chart as shown in Figure 2.5 is then created by this study based on the values in Table 2.10.

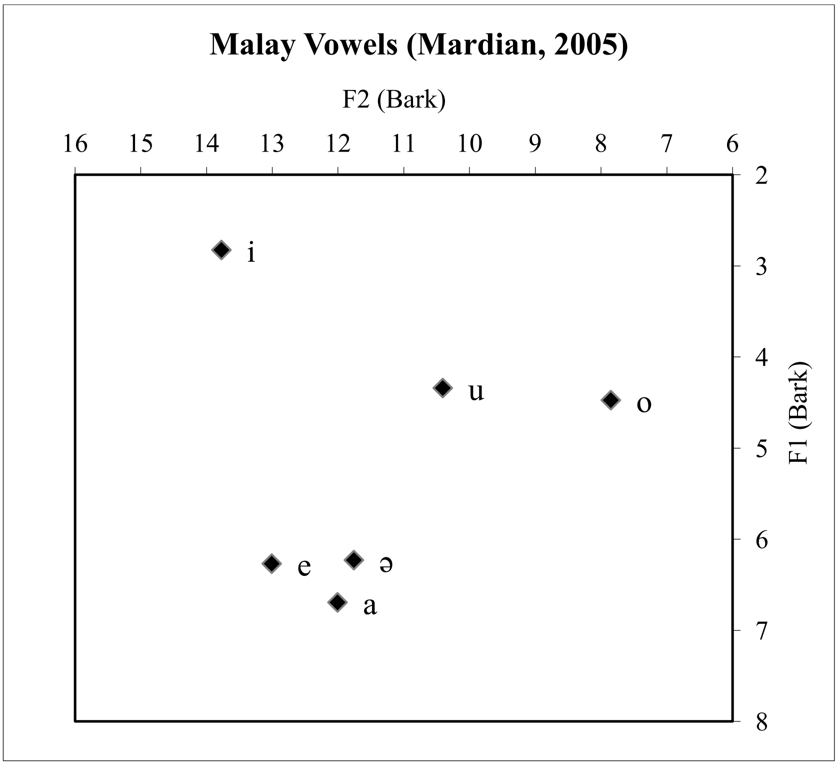


Figure 2.5: Plot of Mardian's (2005) Malay vowels

Based on Figure 2.5, /i/ and /e/ are seen to be positioned in the front of the vowel space as showed by Teoh (1994) in Table 2.8, with /i/ being produced more fronted than /e/. The vowels /ə/ as the mid central vowel and /a/ as the open central vowel in

Table 2.88, are also seen to be positioned centrally in Figure 2.5. However, the F1 values between /ə/ and /a/ is seen to be close with a difference of only 55 Hz, and this indicates that /a/ is produced with little open lips by the Malay speaker in Mardian's (2005) study. The back vowels /u/ and /o/ also show that /u/ (F2 at 1333 Hz) is produced much more fronted than /o/ (with F1 at 900 Hz), thus, their F1 values are very close together with the difference of only 15 Hz.

Another recent acoustic study on Malay vowels is by Shaharina and Shahidi (2012). The main focus of their research was to present and compare the acoustic analysis of six

Malay vowels produced by five Malay males and five Malay females. A wordlist of 90 words was given, and each word was repeated five times. Unfortunately, the words in the wordlist and how the words were extracted were not presented in the paper. The F1 and F2 average values for each vowel produced by the male and female speakers from their study are presented in Table 2.11.

Table 2.11: F1 and F2 Average Values (Hz) of Malay Vowels for Males and Females (reproduced from Shaharina & Shahidi, 2012, pp. 305-307)

Formants	Gender	i	e	a	ə	o	u
F1	Male	319.54	481.05	715.67	501.28	575.54	430.20
	Female	384.50	494.05	738.67	556.55	597.81	447.98
F2	Male	2411.60	2188.79	1597.18	1702.39	1058.60	1285.45
	Female	2490.84	2293.75	1622.60	1895.87	1326.18	1393.53

Figure 2.6 shows the plot of vowels in Bark for the Malay male and female speakers from Shaharina and Shahidi (2012).

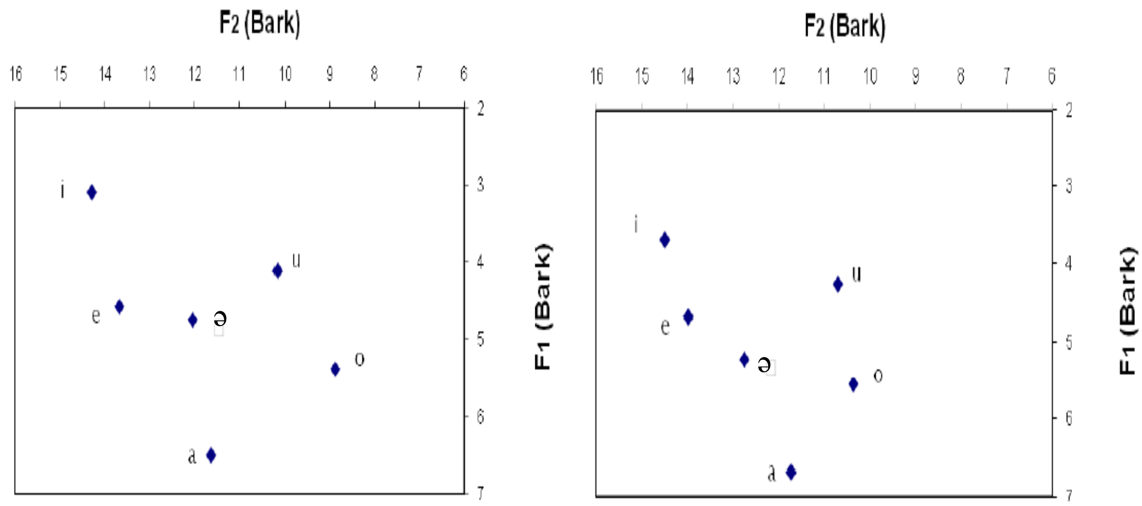


Figure 2.6: Plot of vowels for Malay males (left) and females (right) (source: Shaharina & Shahidi, 2012, p. 309)

Shaharina and Shahidi (2012) concluded that each vowel production between males and females showed significant differences based on the F1 and F2 values. Based on the vowel placements in Figure 2.6, despite the fact the mean scores of F1 and F2 values for female speakers were higher compared to males, it is also seen that the vowel production by males are more spread in the vowel space compared to females. Furthermore, for /ə/ and /a/, they are seen to be produced by the males quite centrally in the vowel space. Thus, /ə/ for the females are seen to be produced more fronted than /a/ in the vowel space. As for the back vowels, the males produced /u/ more fronted than their /o/ compared to the females.

To compare the findings from Mardian (2005) with the findings from Shaharina and Shahidi (2012), this study has plotted their vowel values as shown in Figure 2.7.

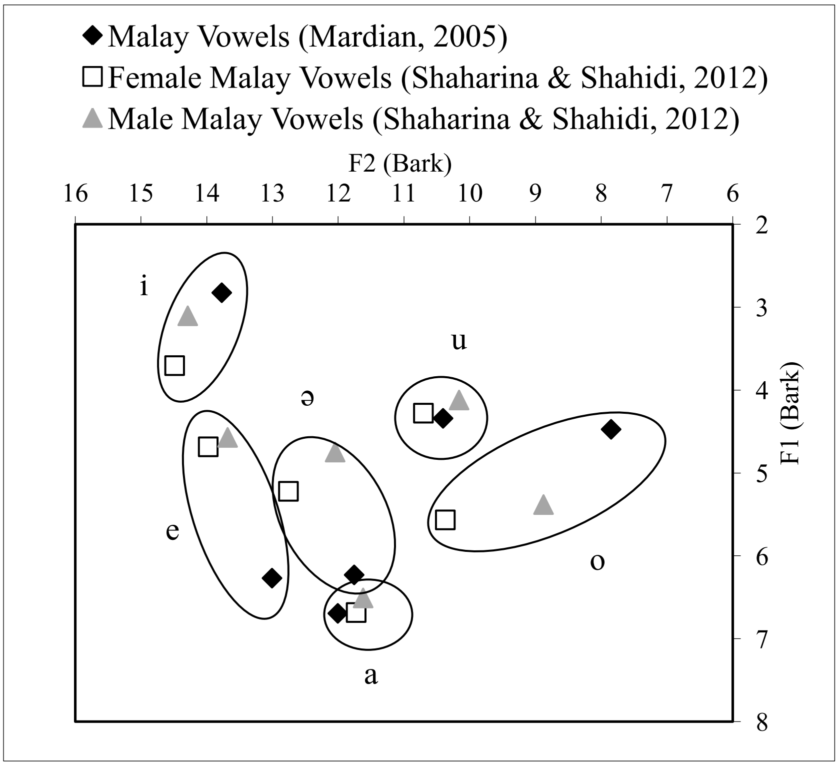


Figure 2.7: Plot of Malay vowels from Mardian (2005) and Shaharina & Shahidi (2012)

Based on Figure 2.7, the scatter of /a/ from Mardian (2005) and Shaharina and Shahidi (2012) are very close together, and so is /u/. This indicates that /a/ and /u/ were produced similarly by the speakers from both studies. The vowel /i/ are scattered at the front of the vowel space, even though they were produced with different F1 and F2 values by the speakers, thus, their positions do indicate a high front vowel for SM. However, variability is found in the production of /e/, /ə/ and /o/. The speakers in the study by Shaharina and Shahidi produced /e/ and /ə/ quite higher than those by the speaker in the study by Mardian. The speakers in Shaharina and Shahidi also produced /o/ more fronted than Mardian's, with the females' /o/ in Shaharina and Shahidi at the most front compared to others.

The discrepancies from the two studies could be due to the speakers and their gender. For Mardian (2005), we do not know the gender of the one informant who participated in this study. The differences may also be due to the words these studies employed to elicit the target vowels and the approach used to do so, which are unknown. Nonetheless, their studies have managed to plot Malay vowels in the vowel space with regard to their qualities based on an acoustic approach compared to previous studies on Malay vowels that were described auditorily.

2.4.1.2 Standard Malay Diphthongs

Three diphthongs in SM are /ai/, /au/ and /oi/, which typically occur in open syllables (Asmah, 1993; Indirawati & Mardian, 2006; Teoh, 1994), for example: *kerbau* [kərbau] 'buffalo', *pandai* [pandai] 'smart' and *sepoi* [səpoi] 'blowing softly' (Asmah, 1993, p. 140). Due to borrowed words from other languages, /ai/ and /au/ may occur at the first syllable of a word, for example: *aulia* [aulija] ‘holy’, *taulan* [taulan] ‘associate, colleague’, and *hairan* [hairan] ‘astonished’.

2.4.2 Kedah Dialect Vowels

Kedah is located in the north-western part of Peninsular Malaysia and is one of the states in this country. The North-western dialect is akin to the one spoken in Perak Utara, Perlis and Pulau Pinang (Asmah 1993; Ismail, Abdul Jalil, Nor Hazizian, Ab. Halim, Ismail, Saidun & Saad, 2002). Asmah (1993) further explains that although Perlis and Penang (including Seberang Perai) are now federal states in Malaysia, but historically, they were once a part of the Sultanate of Kedah (the earliest sultanate on the Malay Peninsula, founded in 1136). The first separation with the sultanate of Kedah started when Pulau Pinang pledged to be a part of the East India Company in 1786, while Perlis was given to the Siamese in 1821.

The spread of KD went along with the expansion of its kingdom all the way along the west coast of the Malay Peninsula and its neighboring islands from Satun in Southern Thailand; nearly all the way south to the Perak River (Collins, 1989). Based on Ismail (1973, as cited in Collins, 1989), Kedah Malay is also spoken in at least two communities in the northeast coast of Sumatra in Indonesia. Throughout its reign, this Sultanate had been attacked by the Siamese, Sultanate of Malacca, the Portuguese, Acehnese, British and Japanese. It finally became one of the states in the Federation of Malaya in 1948. It borders the mainland part of the state of Perlis and Thailand to the north, and the state of Perak to the south and Penang to the southwest. The popular tourist island of Langkawi is also part of the state of Kedah.

In KD, there are also sub dialects (Asmah, 1993). However, it is stated that *"perbezaan-perbezaan dari satu tempat ke satu tempat terlalu kecil untuk diperkatakan dalam perbandingan"* [the differences from one place to another is too small to be compared] (Asmah, 1993, p. 191). Asmah (1993) further notes that the sub dialect of coastal Kedah or *Subdialek Kedah Persisiran* is considered as the standard dialect of Kedah. It is used in formal speech and is the ultimate dialect of the royal family.

This following section discusses the vowels of KD.

2.4.2.1 Kedah Monophthongs

KD has eight monophthong vowels, which are /i/, /e/, /ɛ/, /ə/, /a/, /u/, /o/ and /ɔ/ (Asmah, 1993; Ismail, et al., 2002). Compared to SM, KD has two more vowels, which are /ɛ/ and /ɔ/. All of the vowels can occur at all positions of the syllable (initial, medial, final), except for /ə/ and /o/. The vowel /ə/ can only occur at the initial and medial position, for example: *emas* [əmas] 'gold' and *berkat* [bərkat] 'blessing'. The pronunciation of /i/ and /u/ in word final syllables are similar to SM.

Some vowel features in KD that differ from SM are (from Asmah, 1993, pp. 192-193):

- the sound /a/ in word final syllable in SM is [ə], whilst in KD it is maintained as /a/, for example:

  SM *apa* [apə] 'what' → KD *apa* [apa] 'what'

  SM *ada* [adə] 'exist' → KD *ada* [ada] 'exist'

- -il in word final syllables in SM are articulated as /e/ in KD, for example:

SM *katil* [katil] ‘bed’ → KD *kate* [kate] ‘bed’

SM *sambil* [sambil] ‘while’ → KD *sambe* [sambe] ‘while’

- -el in word final syllables in SM are articulated as /ɛ/ in KD, for example:

  SM *comel* [ʧomel] ‘cute’ → KD *come* [ʧomɛ] ‘cute’

  SM *bogel* [bogel] ‘nude’ → KD *boge* [bogɛ] ‘nude’

- -oh in word final syllables in SM are articulated as /ɔ/ in KD, for example:

  SM *jodoh* [dʒodoh] ‘fate’ → KD *jodo* [dʒɔdɔ] ‘fate’

  SM *bodoh* [bodoh] ‘stupid’ → KD *bodo* [bɔdɔ] ‘stupid’

A study by Inon (1985) who conducted a comparison of styles and dialects of Kedah and Kelantan with Standard Malay also reported some differences in phonology (vowels and consonants), morphology and style. The aim of the study was to provide better understanding of the verbal mechanics of story-telling. The Kedah dialect was referred to as “Asun” in the paper as the informant was from a village called Asun in Kedah, and the Kelantan dialect was termed as KTN. The data for each dialect was each obtained from one adult male speaker; both were *dalangs* (traditional puppet story-tellers). The *dalang* from Kelantan was from Kota Bharu. The data were recorded during their performances. Between Kedah and Standard Malay, specifically for the monophthongs, it was reported that (Inon, 1985, pp. 54-55):

1. /ə/ - the pronunciation of final /a/ in SM is [ə], in KD it is [a] with a part of the tongue between center and back in a fully open position. This finding is also similar to Asmah (1993). Some examples are:

   - *apa* ‘what’: in SM [apə], in KD [apa]

- *buta* ‘blind’: in SM [butə], in KD [buta]

2. /o/ - when the phoneme /o/ is present in both syllables of two syllable words, SM realizes both vowels as [o], which is articulated with full lip rounding (see Zuraidah, 1997). In KD, both vowels are produced as [ɔ] and articulated with lip rounding. Some examples are:

   - *sotong* ‘squid’: in SM [sotoŋ], in KD [sɔtɔŋ]
   - *botol* ‘bottle’: in SM [botol], in KD [bɔtɔi]

   In certain two syllable words where /o/ occurs in the first syllable, /o/ is changed to [u]. Some examples are:

   - *boleh* ‘can’: in SM [boleh], in KD [buleh]
   - *tonggeng* ‘bend’: in SM [toŋgeŋ], in KD [tuŋgiŋ]
   - *tores* ‘scratch, cut’: in SM [tores], in KD [tuɤeh]

3. The vowels /i/ and /a/ following the other in a syllable are often contracted by KD into a single [a] or [ɛ]. Some examples are:

   - *siapa* ‘who’: in SM [siapa], in KD [sapa]
   - *biasa* ‘usual’: in SM [biasa], in KD [bɛsa]
   - *malaikat* ‘angel’: in SM [malaikat], in KD [malɛkat]

3. The vowels /u/ and /a/ following the other in a syllable are often contracted by KD into a single [ɔ] or [o]. Some examples are:

   - *kuala* ‘estuary’: in SM [kuala], in KD [kɔla]

- *laut* ‘sea’: in SM [laot], in KD [lot]
- *daun* ‘leaf’: in SM [daon], in KD [dɔn]

2.4.2.2 Kedah Diphthongs

Diphthongs in KD consist of four sounds, which are /ai/, /ui/, /oi/ and /au/ (Asmah, 1993; Ismail, et al., 2002). Some vowel features in KD that differ from SM are (from Asmah, 1993, p. 193):

- /ai/ and /au/ can occur at the final syllable of a word and at the medial positions between the consonants of stops or plosives, which are /p/, /t/, /q/ and fricative /h/. For example:

  SM *lepas* [ləpas] ‘after’ → KD *lĕpayh* [ləpaih] ‘after’

  SM *pahit* [pahit] ‘bitter of taste’ → KD *payt* [pait] ‘bitter of taste’

- /oi/ only occurs at the final position of a word such as *boroi* /bɔrɔi/ ‘pot bellied, having a big stomach’ (from Ismail, et al., 2002).

2.5 Acoustic Characteristics of Vowels

This study attempts to perform an instrumental analysis to describe the Acehnese vowels. As previously discussed in 2.3, Acehnese vowels have been studied before, but the studies mostly analyzed its sound system through auditory descriptions. This has left inconsistencies in the identification and description of Acehnese vowels. To further present a systematic description of the qualities of Acehnese vowels, this study, therefore, tries to perform another way of describing these vowels by adopting a more scientific measure.

Investigations in acoustic theories of speech production relate the shape of the vocal tract to the acoustic signal (Fant, 1981; Stevens & House, 1955). The speaker's vocal tract operates as an acoustic filter through which passes the glottal tone of voicing. The glottal tone composes of a fundamental frequency and its harmonics. A speaker never holds the shape of his vocal tract steadily for more than a moment while talking. As the frequencies stop, the shape of the supraglottal cavities, or air cavities, and the associated resonances, differ almost constantly (Abdul-Rahman, 2006).

Formants can be digitally tracked by formant-based speech production and linear predictive coding (LPC) (Harrington, 2010). A formant is the dark band on a wide band spectrogram that corresponds to a vocal tract resonance. It represents a set of adjacent harmonics, which are advanced by a resonance in some part of the vocal tract (Hagiwara, 2009). Prinsloo (2000, p. 28) specifically listed some features of formants to study voiced speech, which are:

- intuitiveness
- robustness against channel noise and distortion
- low dimensionally and hence easily perceived and analysed by a human
- most immediate source of articulatory information and
- there is a close relation between formant parameters and model-based approaches to speech perception and production

The first two resonances are identified as the first formant (F1) and the second formant (F2) for a specific vowel or vocal tract configuration. These formants are numbered from the lower to higher frequency. The different shapes of the vocal tract and the different positions of the tongue generate different formant patterns, and the peaks of energy around the frequencies that correspond to the natural frequencies of the supraglottal cavities during the articulation of the sounds describe the different vowels that are produced (Ladefoged, 2006). Different vowels are produced by the change of positions of the tongue and thereby changing the shape of the vocal tract. They are usually classified by the part of the tongue that is raised: front, middle or back, and according to the degree of rising which takes place, namely: close, half-close, half-open and open. For example, /i/ is located at the front of the mouth and produced with unrounded lips and tongue, while /o/ is located at the back of the mouth and produced with rounded lips and tongue.

A number of methods have been developed on the normalization of data measurements that is sometimes necessary when dealing with inter-speaker differences to reduce the impact of specific speaker effects and to make comparisons of their vowel quality viable, especially with speakers of different sex (Jacobi, 2009). Comparison of formant values is precarious across speakers of different sex. For adult females, the length of the vocal tract is around 13 cm and for adult males, it can vary to over 18 cm (Maragakis, 2008). The vocal tracts of women are shorter; therefore, they have higher resonance frequencies than those of men (Flynn, 2011). Their formant frequencies are roughly 10% to 15% higher; therefore, they produce clearer speech compared to males (Foulkes & Docherty, 1999; Simpson, 2009; Wang & van Heuven, 2006). Due to this, Jacobi (2009, p. 27) states that "females are supposed to have more dispersed vowels, and for variation analysis, a normalization procedure should account for these sex differences, so that linguistic effects in terms of gender differences can still be differentiated from biological sex". Specifically, most studies conduct the normalization procedure for their formant data for the following reasons (Flynn, 2011, p. 2):

1. to minimise or eliminate inter-speaker variation due to inherent physiological or anatomical differences;
2. to preserve inter-speaker variation due to social category differences, including age, gender and dialect, or due to sound change;
4. to maintain vowel category and phonemic differences;
5. to model the cognitive processes that allows human listeners to normalise vowels uttered by different speakers.

The normalization technique then converts the acoustic vowel space to group together phonetically similar vowels and separate phonetically different vowels (Watson, Maclagan & Harrington, 2000). Normalization research generally concentrates on male/female differences in vocal tract size and shape (Johnson, 2005), therefore, when speakers being studied are of the same sex, normalization for vocal tract length at most times are not required, such as the study by Konopka and Pierrehumbert (2010) on the vowel dynamics of Mexican Heritage English, which had participants of adult females only.

2.5.1 Data for Vowel Analysis

The data used for acoustic analysis of vowels can be collected from a number of sources. An approach that is commonly employed is to record speakers to produce words that contain the target vowels from a word list. Some studies have the speakers read the word list and repeat each word a number of times (e.g. Alghamdi, 1998; Aronson, Rosenhouse, Rosenhouse & Podoshin, 1996; Leemann, 2008; Man, 2007; Maxwell & Fletcher, 2010; Sfrakianaki, 2002; Tsukada, 2008). There are also studies that embed the words in a carrier sentence (e.g. Lee & Lim, 2000; Pillai, Zuraidah, Knowles & Tang, 2010; Verhoeven & van Bael, 2002; Winn, Blodgett, Bauman, Bowles, Charters, Rytting & Shamoo, 2008) such as "Say ___ again" to be said by the informants repeatedly. The advantage of using the carrier phrase is that the controlled data are equivalent and the effect of the initial and final sounds is constant because the vowels appear within the same phonetic environment (Verhoeven & van Bael, 2002).

Another method to collect acoustic data from speakers is through questionnaires designed to elicit single words that illustrate the target vowels. These elicits are performed in the manner of a quiz and further clues and even flash cards are given until the speakers could produce the correct target word. This technique was successfully applied by Walters (2006) in extracting target words from his speakers to study the phonology of Rhondda Valleys English in south east Wales.

The rationale of word list is to have control over the phonetic environment of the vowels being investigated (King, 2006). Preferably, the vowels occur in an identical environment, where stops and fricatives are favored as they have minimum effect on vowels (King, 2006), such as in:

- [sVs] contexts (e.g. Alghamdi, 1998)
- [hVd] contexts (e.g. Cox, 2006; Hawkins & Midgley, 2005; Leemann, 2008; Ferragne & Pellegrino, 2010; Pillai, et al., 2010)
- [bV] or [bVt] (e.g. Winn, et al., 2008)
- [hV] (e.g. Maxwell & Fletcher, 2010)

Sometimes, to provide identical phonetic environments for the vowels is not possible. Therefore, they can be retained in the environment within voiceless consonants. Lee and Lim (2000), who studied the monophthongs of Singapore English, employed this approach where the vowels occur in all monosyllabic open syllables with bilabial onsets. Tsukada (2008), who studied the vowels of Thai English, also used vowels that occurred in monosyllabic words ending with /p/, /t/ and /k/. Similarly, King (2006), who studied the vowels in three Austronesian languages in New Ireland, used words where the vowels follow the voiceless consonants /p/, /t/, /k/ or /s/. Verhoeven and van Bael (2002), who studied the monophthongs in Southern Standard Dutch, used vowels preceding a voiceless labial stop and followed by a voiceless alveolar stop.

On the other hand, there are also studies that employ words with vowels that precede or follow sounds other than stops or fricatives. Sfakianaki (2002) who studied the Greek vowels, for example, used word lists to extract /i/ and /e/ that precede initial or final /r/ and /m/, and medial /l/ in stressed and unstressed vowels. The formants extraction at the midpoint of the vowel was deemed enough to avoid effects from the surrounding sounds. Likewise, Wayland (1996) had word list with vowels preceding nasals and approximants in meaningful words in studying the Battambang Khmer vowels. The choice to use different environments can be caused by the constraints on possible combinations of consonants and vowels of the language under study. Consequently, Deterding (2003) suggests avoiding vowels that occur after the approximants /j/, /w/ and /r/ or before /l/ as these sounds have an effect on vowel quality. However, this is sometimes unavoidable if there is no vowel occurring in words in the suggested environment found in the language under study. Therefore, other environments are used to allow researchers to collect the sounds they need in meaningful words.

Another form of word list is lexical sets. The linguistic concept of lexical sets is a group of words that share a specific form or meaning. This means each word in the group refers to a similar pronunciation of a particular group of words in a language. A well-known lexical set that have been used widely by researchers in examining vowels in varieties of English is the one by Wells (1982, see Table 2.12).

Numerous studies use Wells lexical set to explain the varieties of English. Among them are Watt and Tillotson (2001) who examined the fronting of /o/ in Bradford English based on the GOAT lexical set. Wells lexical set was also used to explain the varying degrees of accents in the British Isles (Foulkes & Docherty, 1999) and to specifically describe changes in the London vowel system of young and elderly informants from inner and outer London (Torgersen, Kerswill & Fox, 2006).

Table 2.12: The standard lexical sets by Wells (1987)
(reproduced from Wells, 1987, p. 123)

The standard lexical sets			
No.	RP	GenAm	keyword
1.	ɪ	ɪ	KIT
2.	e	ɛ	DRESS
3.	æ	æ	TRAP
4.	ɒ	ɑ	LOT
5.	ʌ	ʌ	STRUT
6.	ʊ	ʊ	FOOT
7.	ɑː	æ	BATH
8.	ɒ	ɔ	CLOTH
9.	ɜː[1]	ɜr	NURSE
10.	iː	i	FLEECE
11.	eɪ	eɪ	FACE
12.	ɑː	ɑ	PALM
13.	ɔː	ɔ	THOUGHT
14.	əʊ	o	GOAT
15.	uː	u	GOOSE
16.	aɪ	aɪ	PRICE
17.	ɔɪ	ɔɪ	CHOICE
18.	aʊ	aʊ	MOUTH
19.	ɪə[1]	ɪr	NEAR

‘Table 2.12, continued’

20	ɛə[1]	ɛr	SQUARE
21.	ɑː[1]	ɑr	START
22.	ɔː[1]	ɔr	NORTH
23.	ɔː[1]	or	FORCE
24.	ʊə[1]	ʊr	CURE
[1]with /r/ following before a vowel only.			

However, there are also shortcomings in the use of lexical sets because phonological systems and phonetic realizations are always evolving (Ferragne and Pellegrino, 2010). For this reason, the Wells lexical set has been modified in some studies. An example is a study by Hickey (1999) on Dublin English. More words were added, which are MEAT, GIRL, DANCE and PRIDE as those are deemed necessary to capture the vowel realizations of Dublin English. A study by Ferragne and Pellegrino (2010) that investigated the vowels of male speakers in 13 accents of the British Isles based on formant frequencies further employed test-words in /hVd/ to correspond with the lexical set (e.g. ‘heed’ corresponds to FLEECE, ‘hid’ corresponds to KIT, ‘head’ corresponds to DRESS).

Most of the studies mentioned employed meaningful words to obtain the target vowels. Nevertheless, Alghamdi (1998), who conducted comparative study of Arabic vowels, presented both meaningful and unreal words to the informants. The words where syllables with long vowels were meaningful words, but the ones with short vowels were unreal words. His rationale for doing so was to achieve a constant environment for the vowels being studied, which was [sVs]. On the other hand, this choice is deemed to lead to an unnatural approach towards the vowels of language being studied. Ferragne and Pellegrino (2010) and Mayr and Davies (2011) mention that speakers have problems with unreal words and in turn, it may influence the reliability of the data. Although data sometimes cannot be sustained to be consistent in one place and manner, Winn, et al. (2008, p. 6126) state that, it must be "in the interest of ensuring that all target stimuli were real words".

In acoustic studies, data are also collected from segments of read speech. Studies on Dutch diphthongs, for example, are mostly conducted through read speech or words or syllables spoken in isolation such as those by van de Velde (2001), Adank (2004) and Smakman (2006) (as cited in Jacobi, 2009). Through this method, speech segments with longer duration and clearer articulation compared to spontaneous speech are obtained (Jacobi, 2009). The use of read texts employed by Salbrina (2006), for example, had informants read of *The North Wind and The Sun* (NWS), to examine the vowels of Brunei English. However, it was found that the formant measurements of the diphthong /æ/ may not represent its true quality as all instances of the vowel in the passage of NWS were preceded by /r/ that affects neighboring vowels. Deterding (2006) also highlights other shortcomings from NWS text, such as the lack of /ʒ/, medial and initial /z/, initial /ɵ/, word-final /l/, word-final consonant clusters ending in /s/ or /z/ and the absence of tripthongs such as /aɪə/ and /aʊə/. Therefore, using specific texts to collect vowels may result in not obtaining all of the target vowels under study. King (2006) further reveals that if the text is not exclusively created to contain all target sounds; there is no control over influences on vowel quality from different environments and on the frequency of the target sounds.

Another context that is used to extract vowels is through spontaneous speech that is considered a more natural approach in human communication. Van Heuven, Edelman and van Bezooijen (2002) assert that the best way to collect vowels are from speech that is unrehearsed and produced spontaneously compared to from speech that is produced by reading it out. This is because vowels that are collected in citation form may be hyper-articulated or articulated too carefully and do not correspond to true representations of the vowels. The various sources to collect spontaneous speech are from interviews (Deterding, 2000) or to have the speakers describe pictures (Lee & Lim, 2000). Other methods of extracting data from connected speech are from recordings of a set of monologues such as the news and commentaries (Deterding, 1997); a televised series of talk shows (van Heuven, Edelman & van Bezooijen, 2002) and telephone exchanges (Jacobi, 2009). There are also studies where two speakers are requested to chat freely and unmonitored for 45-60 minutes while being recorded (Lennes, 2003). On the other hand, the disadvantage of obtaining the vowels exclusively from spontaneous speech is that it may not cover all of the vowels being investigated. The vowels are further prone to effects from elision, intonation, stress, vowel reduction and other phenomenon related to connected speech.

Further, data extracted from spontaneous speech are often not found to fit in the phoneme meant by the speaker (Jacobi, 2009). This implies that the vowel the speaker means to say may not be pronounced fully because it is said in a speech that is produced faster than citation speech. Additionally, a vowel spoken less clearly such as from spontaneous speech is likely to be reduced (Harrington, 2010). Subsequently, there is a deviation from its positions in an acoustic space and marked as centralization because the vowel is produced closer to the center of the speaker's vowel space than in clear speech (e.g. citation form). In other words, this causes vowel recognition to be more centralized in the articulatory acoustic vowel space. Thus, from isolated tokens from word lists or read texts, the phoneme categories are found to be more dispersed and tend to overlap because of the speakers' awareness of their productions. As stated in

Ferguson and Kewley-Port (2007, p. 1253), "it may be that talkers who make their vowels more dynamic in clear speech deliberately slow down to avoid overshooting the formant frequency targets for individual vowels". Therefore, in the clear-speaking mode, there are longer vowel durations, higher mean values of fundamental frequency, greater pitch range, and larger vowel space areas in clear speech compared to conversational speech (Li & So, 2006).

Euclidean distance, or ED, is one of the methods to measure the vowel space expansion from the center of the vowel space (Harrington, 2010). Vowel centralization is measured by calculating the distance of each vowel from the centroid of all vowels in Bark (Deterding, 1997). A centroid is defined by Harrington (2010, p. 193) as "a single point that is at the centre of the speaker's vowel space". In a two dimensional space, this distance is estimated by summing the square root of the horizontal and vertical distances between the points and taking the square root. The formula used to obtain ED in Bark is as Equation 1 below (Harrington, 2010, p. 191):

$$\boxed{= \mathbf{SQRT}(((\mathbf{5.35} - \mathbf{F1})\text{^}\mathbf{2}) + ((\mathbf{11.81} - \mathbf{F2}))\text{^}\mathbf{2})}$$

Where: the values of F1and F2 in the formula are in Bark.

The measurement of ED is by calculating the average F1 and F2 values of all vowels, except the central vowel. The distance shows the speakers' vowel productions if it is more central or peripheral in the vowel space, and peripheral vowels are more distant from one another compared to the central ones (Harrington, 2010). The acoustic vowel space is also influenced by the size of the vowel inventory where the larger the vowel inventory, the bigger the acoustic space will be (Al-Tamimi & Ferragne, 2005; Bradlow, 1995). Harrington (2010) further noted that this method is not just applicable for representing the correlation between vowel positions and vowel hyper articulation, but its measurements can also be employed to calculate how close one vowel space is to another to account for sound change that is relevant for sociolinguistic studies.

2.5.2 Monophthongs

The characteristic of a monophthong is that it does not change over the duration of the vowel production. In its production, the positions of the articulators, usually the tongue, jaw and lips (in the case of rounded vowels), are maintained for the period of the vowel. These vowels are transcribed with one letter, such as in the Acehnese word *kap* [kap] ‘bite’ and in the Malay word *tak* [tak] ‘no, not’. The vowel looks constant on the spectrogram (Lee & Lim, 2000) because the articulation at the beginning and ending of the vowel is relatively static and does not glide up or down except towards the subsequent sound of a new point of articulation.

To analyze the characteristics of monophthong vowels, the Formant Frequency Model is universally used (e.g. Cho, Jun, Jung & Ladefoged, 2007; Deterding, 2003; Jurgec, 2005; Man, 2007; Pillai, et al., 2010; Salbrina, 2006; Sfakianaki, 2002; Verhoeven & van Bael, 2002; Winn, et al., 2008). This model is derived from the correlation between vowel quality and formant frequencies. The two main features of vowel quality that are used to contrast one vowel with another are the height and fronting/backness (Ladefoged, 2006). The measurement of the lower resonances of formant frequencies in the acoustic signal determines its quality (van Heuven, Edelman & van Bezooijen, 2002). Generally, only F1 until F2 are analyzed because higher formants are known to have less energy, therefore, less influence on perception. On the other hand, F3 and F4 contrast more than F1 and F2 owing to speaker’s characteristics and as a result, higher formants provide less effective phonetic information than the lower formants (Hossain, Rahman & Ahmad, 2007). Jacobi (2009) also agrees that higher formants take account of mainly speaker specific information. It is the first two formants of F1 and F2 that are essential for vowel identification; they are considered sufficient to describe the quality of monophthongs (Fry, 1979; Jacobi, 2009; Hayward, 2000; Hossain, Rahman, & Ahmad, 2007). F1 is related to vowel height that is the degree of constriction and specifies the vertical tongue position and mouth opening, whilst F2 reflects the expression of the front/back dimensions and is based on the length of the front cavity (Jacobi, 2009; Watt & Tillotson, 2001).

Vowels are also likely to be described in terms of frequency numbers (Ladefoged, 2006) as this will make it possible to analyze sounds and measure the actual frequencies of the formants. Generally, the higher the F1 value then the lower or more open the vowel, and the lower the F1 value then the higher or more close the vowel. Whilst for F2, the higher the F2 value then the more front is the vowel, and the lower the F2 value then the more back is the vowel. For example, a high front vowel like /i/ will have a relatively low F1 and high F2. Furthermore, Bullock and Gerfen (2004) also assert that lip rounding increases vocal tract length, which initiates lower formants, generally the second and third formants (Ladefoged, 2006). In open vowels, the high F1 frequency also imposes an elevation in the F2 frequency and this dimension of backness is measured by the difference between the first and second formants. So the closer they are together, the further back a vowel sounds.

Many researchers have used the first two formants (F1 and F2) as cues for their acoustic description of vowels. This can be found in the work by Alghamdi (1998) on the comparative study of three Arabic dialects, Chen (2008) on the vowels of Shanghai

Chinese, Deterding (2003) on Singapore English, Foulkes and Docherty (1999) on British English and Winn, et al. (2008) on the Vietnamese monophthongs, among many others. Deterding (2003) measured and compared the vowels of Singaporean English with that of British English. His subjects were five educated female and five educated male Chinese Singaporeans training to be school teachers in the National Institute of Education in Singapore. They were interviewed for five minutes on their vacations, previous trips abroad and plans for the future. The data for the British English vowels were from five male and five female BBC broadcasters recorded in the MARSEC corpus that had been reported in his previous work in 1997. Ten examples from each vowel were identified from every subject; however, vowels following /w/, /j/ and /r/ and vowels preceding final /ŋ/ or /l/ were passed to avoid co-articulatory effects on the vowels being investigated. The measurements of the first two formants were made using CSL software from KAY. The computer-based spectrograms with overlaid Linear Predictive Coding read formant tracts. The results indicated that the distinction between /i:/ and /ɪ/ and also /e/ and /æ/ are not maintained in Singaporean English, and the distinction between /ɔ/ and /ɒ/ is small. Additionally, Singaporean English /u:/ is pronounced further back than British English /u:/.

Winn et al (2008) conducted a study on the Vietnamese monophthongs to further explain its vowel inventory. Data was collected from four native speakers of Vietnamese, including three Northern dialect speakers (one female, two males) and one Southern dialect speaker (female), ranging in age from 42-64 years. The study also evaluated the production of these vowels by adult learners whose native language was English, with their data collected from six non-native speaker participants including three Northern dialect learners (all male) and three Southern dialect learners (one female, two males), ranging in age from 30-50 years. The monophthongs under evaluation were *i, ư, u, ơ, ô, â,* and *ă*, which appeared with all possible tones for each of three syllable types: open, stop-final, and nasal final such as *ba, bat,* and *bang*, except for *â* and *ă* that appears only in stop-final and nasal-final syllable in the Vietnamese phonology. The participants were asked to produce three-word sentences in response to individual target words that appeared on the computer screen. The data was interpreted using PRAAT version 5.0.14. The F1 and F2 values were measured at the midpoint of the vowel. From the modified vowel normalization procedure, new data on the representation of the orthographic *ư* and *ơ* in Vietnamese was provided. It is proposed that these vowels should be represented as the central vowels /ɨ/ and /ə/, respectively. The sounds *ơ* and *â* that were previously thought to only differ in duration were found to have quality differences also. For non-native speakers of Vietnamese, it is noticed that their production of the central and back vowels are insufficient for the separation of these vowels compared to native speakers. The long and short vowels were also not distinct in the non-native speakers. This implied that vowel duration contrasts are complex to native speakers of English.

Besides using the F1 and F2 values at the midpoint of a vowel to measure it such as the studies above, there are also other ways to measure vowels. Some studies have also measured a vowel in slices or time points of its whole duration. Kamiyama and Vaissière (2009), in studying the perception and production of French vowels by Japanese learners, measured the first four formants of each target vowel in 5 different time zones of its whole duration, which were 20%, 40%, 60%, 80% and 100%. Their rational for measuring F1-F4 was to "better visualise the whole acoustic characteristics of vowels produced by native and non native speakers" (Kamiyama & Vaissière, 2009, p. 16). Afterwards, the mean values throughout the vowel were also measured and compared with the mean values measured at those points. The target vowels were embedded in carrier sentences and the informants were asked to read the sentences one by one, twice in a row. Another study by Gordon (2012), who examined the speaking style effects on the vowel production variability for native monolingual English speakers, also measured the F0, F1, F2, F3, and F4 for each point in time at 20%, 50%, and 80% of the vowel to see the changes in its dynamic property, even though later the F3 and F4 were both not used for their study. The vowels were extracted from the informants by having them read the target syllables in carrier phrases. Both of these studies have similar techniques for extracting vowel sounds from informants produced in clear and conscious speech. It has been found that the dynamic properties of vowels during clear speech increases in duration (Ferguson & Kewley-Port, 2007). This is something to be borne in mind when dealing with read speech contexts.

Most studies that extract vowels from informants from clear speech by placing the target vowels in a carrier sentence have also been measured at just the temporal midpoints of vowels, such as by Feng (2009), Hubais and Pillai (2010), and van Leussen, Williams and Escudero (2011), among many others. Taking into consideration that the characteristic of a monophthong does not change over its duration of articulation, the F1 and F2 of vowels that are measured at the midpoint are regarded as sufficient. This is considered as its point of steady state where there is the smallest amount of influence from neighboring sounds (Ladefoged, 2003).

Various frequency scales are used for vowel analysis, such as the Koenig scale, the cochlear position scale, the Mel scale, or the Bark scale, and they are all based on auditory findings (Jacobi, 2009). Watt, Fabricius and Kendall (2010, as cited in Flynn (2011, p. 2), state that “the raw Hertz formant frequencies of different speakers are not directly comparable, and that it is not ideal to plot formant values in Hertz from different speakers on the same formant chart". The rescaling of Hertz frequencies by converting the frequencies into a different scale was to approach a more relevant human vowel perception (Adank, Smits & van Hout, 2004). As carried out in most studies, Zwicker and Terhardt (1980) suggest that values of the formants in Hertz are converted into a Bark scale because it denotes frequencies in the way that we hear them (Traunmüller, 1990).

A Bark scale is described by Stevens (2000, p. 237) as a concept that is used "as a basis for designing filter banks for the analysis of auditory signals, including speech". It is based on the human auditory system, which consists of 24 critical band filters situated in an intersection from low to high frequencies (Zwicker & Terhardt, 1980). Stevens (2000) provides a list of the center frequencies and bandwidths of the critical-band filters proposed by Zwicker and Terhardt (1980). The formula used to convert a frequency *f* (Hz) into Bark (Zwicker & Terhardt, 1980, p. 1524) is as shown in Equation 2:

$$\boxed{\boldsymbol{Zc = 13\,arctan\,(0.76 * F) + 3.5\,arctan\,(F/7.5\,)2}}$$

Where:
- Zc is critical-band rate in Bark
- arctan is applied to numbers in radians
- F is frequency in kHz

These average values may be plotted on an F1-F2 chart. These vowel charts are to "give a valid scientific description of the vowels of a language" Ladefoged (2003, p. 126). Watt and Tillotson (2001, p. 276) also add that, "the formant plots can provide an approximate representation of the relative qualities of individual vowels". Even though some studies plot these vowels on a F2-F1 vs. F1 chart, thus, Hayward (2000, p. 160) recommends the use of the F1-F2 plot saying that the F2-F1 vs. F1 plot "is not very satisfactory because of its effect on the placing of the central vowels". Although there are issues relating to the representation of back vowels in the former, this method is used by many current researchers to show the placement of vowels in the vowel space. These include for General American English and British English (Ladefoged, 2001), Standard Southern British English (Deterding, 1997) and Dutch (van Heuven, Edelman & van Bezooijen, 2002).

2.5.3 Diphthongs

The characteristic of a diphthong is when distinct vowels are articulated in sequence in a conversation and shows a changing vowel quality (Ladefoged, 2006). The acoustic pattern of diphthongs changes gradually due to change in vocal tract configuration of the vowels forming the diphthongs. Therefore, diphthongs are characterized by a changing vowel quality over the duration of the vowel; the first and second formants of the diphthongs can be expected to be less stable compared to monophthong vowels (Lee & Lim, 2000). There are also unitary diphthongs that are heard by listeners as single vowel sounds or known as phonemes.

In Acehnese, an example of a diphthong is found in the word *phui* [phui] 'light (weight)', and in Malay, an example is *sepoi* [səpoi] 'light breeze'. Traditionally, the diphthongs produced with tongue movement from a mid or low to a high position are known as closing diphthongs while those produced from a peripheral to a central position are known as centering diphthongs (Clark & Yallop, 1995). Closing diphthongs typically start with higher F1 and end with a lower F1, such as /ai/ and /oi/. To only measure the onset and offset of F1 would not be very reliable to measure the degree of diphthongization. Gay (1968, p. 1570) explains that diphthong targets are not always in full agreement with the vowels that describe them, such as the onset of /aɪ/ can vary from /a/ to /ae/ and offset from /ɛ/ to /i/. This means that they do not necessarily begin and end with any of the sounds found in simple vowels (Ladefoged, 2001). Sarwar, Ahmed and Tarar (2004) state that they may start from more or less the low central vowel position midway between any two vowels. Thus, Ladefoged (2006) claims that the first part of a diphthong is usually more prominent than the last part as the offset are often short and temporary, making it tricky to determine its accurate quality.

From the study by Gay (1968) who looked at the effects of speaking rates (slow, moderate and fast) on the production of English /aʊ/, /aɪ/, /eɪ/ and /oʊ/, it is found that at fast speaking rate, the end points of the diphthong are not reached, however, the formant values for beginning points are quite stable across changes in rates. Whilst for slow and moderate speaking rates, the steady state of the beginning and ending points of the diphthongs are present. He suggests that the F2 rate of transition is an important indication in characterizing diphthongs as the glide is identified with the F2 movement interval. Therefore, an approach he recommends is to use the rate of change (ROC) (Gay, 1968). He further argues that the ROC allows us to better perceive the distinction between the diphthong sounds rather than just looking at the beginning or end points of the diphthong. The ROC is obtained by the formula (in Deterding, 2000, p. 94) as shown in Equation 3:

$$\boxed{\boldsymbol{F1end - F1onset/duration\ in\ seconds = \ ROC\ (Hz/s)}}$$

Where: the figure obtained is in Hertz per second

For a closing diphthong, the value of ROC will be negative because during vowel production F1 will decrease. For example, the production of /əi/ starts with onset close to /ə/ that has a relatively higher F1 than the offset /i/. Accordingly, the value of F1 from the offset /i/ are deducted from the higher value of F1 from the onset /ə/ and further divided by duration, a negative value is attained and this shows diphthongal movement. ROC was also one of the optional methods suggested by Kent and Read (1992) to describe diphthongs.

Nevertheless, Deterding (2000) also reveals that ROC is not the only method as other studies also use other approaches to describe diphthongs. As quoted by Deterding (2000, p. 95), Ren (1986) measured diphthongs at different times in their trajectories of F2 while Clemont (1993) even proposed to take F3 into consideration. Acoustic studies by Man (2007) who analyzed the diphthongs of Hakka Chinese and by Sarwar, Ahmed and Tarar (2004) who analyzed the diphthongs of Urdu, both used F3 in their measurements. Their rationale was that the three formants can provide critical points that present some meaningful information for the diphthongs, which are (Sarwar, Ahmed & Tarar, 2004, p. 10):

- Onglide of a diphthong, which represents only the first vowel of the diphthong
- Transition phase, in which a shift from first vowel to the second one occurs.
- Offglide of a diphthong, which represents the last vowel in the diphthong.

Furthermore, Mayr and Davies (2011) also measured Welsh diphthongs at the F1 and F2 frequencies at 20%, 35%, 50%, 65% and 80%. The trajectory length, a measure of spectral change that marks the formant movement in the F1-F2 space, and the spectral rate of change or SpecROC were also determined. The rationale of using these methods were to achieve a verification on the dialect-specific changes in spectral dynamics across diphthong trajectories to reveal how similar category may be recognized differently in Northern and Southern Welsh (Mayr & Davies, 2011). On the study of German vowels, Pätzold and Simpson (1997) took the measurements of diphthongs at 20% and 80% of its production. However, those studies had data that were carefully articulated, while Deterding (2000) is unsure if these methods of analysis are appropriate for data from conversational speech and considers the use of ROC to be more suitable for studies on diphthongs from this type of speech.

The use of ROC in measuring closing diphthongs was also employed by a number of studies that compared different varieties of English. Among them are the work by Deterding (2000) who examines the production of /eɪ/ and /əʊ/ by young English speakers in Singapore. Salbrina (2006) investigates the English /eɪ/ and /əʊ/ produced by Bruneian English speakers. There is also Tsukada (2008) who studied the acoustic characteristics of the English diphthongs /eɪ/ and /oʊ/ produced by speakers of Australian English and Thai. Whilst Deterding (2000) and Salbrina (2006) measured the diphthongs at the beginning and ending points of the vowel, Tsukada (2008) extended the measurements of the beginning and ending points at 20% and 80% to further avoid articulatory effects from neighboring consonants.

As mentioned earlier, diphthongs are typically divided into two types, centering and closing. Centering diphthongs must be treated differently from the closing diphthongs because they begin with a more peripheral vowel and ends with a more central one, such as /iə/, /ɛə/ and /uə/, among others. Therefore, Lee and Lim (2000) describe that the change in vowel height (e.g. F1 movement) may not be significant to measure the centering diphthong, but the difference in the front back dimension (e.g. F2 movement) is more important for this type of vowel. For that reason, Lee and Lim (2000) suggest measurements of the ROC average values of both F1 and F2 for centering diphthong. They further mention that the diphthongal movement for the centering diphthongs is identified by "a larger absolute value of ROC that would indicate greater diphthongal movement" (Lee & Lim 2000, p. 103). They had effectively applied this method in measuring the diphthong /eə/ of Singaporean English.

Some studies find it sufficient to study the diphthongs from the ROC values, such as Salbrina (2009), Deterding (2000), Lee and Lim (2000) and Tsukada (2008). Gay (1968, p. 108) mentions some limitations in the use of ROC, as it does not "provide indication of any phoneme sequencing in terms of either formants positions or overall movement". This means that it does not specifically tell information on the position of onglide and offglide of a diphthong in the vowel space. As an alternative, other studies plot diphthongs in a vowel quadrilateral to better obtain their visual representation of their trajectories. These trajectory diagrams in the vowel space provide a better illustration of a diphthong's target positions, its movements and how they vary across varieties. This can be found in the work by Holbrook and Fairbanks (1962) on American English, Wayland (1996), Pätzold and Simpson (1997), Man (2007) on the temporal structure of the diphthongs of Hakka Chinese, King, Harlow, Watson, Keegan and Maclagan (2009) on the changing pronunciation of the Māori language, and Mayr and Davies (2011) on the monophthongs and diphthongs of Welsh. The average frequencies of F1 and F2 from the beginning and ending of a diphthong are plotted as points in an F1 by F2 plane. The points are connected to form trajectories in the vowel space to illustrate the movements of diphthongs.

2.6 Language Contact and Sound Change

To minority communities that still preserve their heritage languages and use them in their daily lives, such as the case of Acehnese that is still spoken largely by Acehnese descents in KpA, sound changes are inevitable due to continuous contact with other languages that are predominantly used in the region. This section examines the literature on language contact and language change to account for explanations on the changes and maintenance that occur in Acehnese that has been transported to another geographical location.

2.6.1 Language Contact

Crystal (2008) defines language contact as the following:

> A term used in sociolinguistics to refer to a situation of geographical continuity or close social proximity (and thus of mutual influence) between languages or dialects. The result of contact situations can be seen linguistically, in the growth of loan words, patters of phonological and grammatical change, mixed form of language (such as creoles and pidgins), and a general increase in bilingualism of various kinds. In a restricted sense, languages are said to be 'in contact' if they are used alternately by the same persons, i.e. bilinguals. (Crystal, 2008, pp. 107-108)

Based on the broad definition above, contact can be said to transpire from when some communication between speakers of different languages or dialects occur and bilingualism is the trigger. The point of language contact is the bilingual speaker and the involvement of two or more languages is the core that results in language change (Sankoff, 2001). The distribution of language change ranges from the larger speech community to smaller groups of individuals. The four major domains of linguistic outcomes from contact are generally found at the levels of phonology, lexicon, syntax or discourse/pragmatics, and morphology/grammatical categories (Sankoff, 2001). Winford (2003, as cited in Olsen, 2008) explains that the outcomes are due to different social situations and the phenomenon can be classified and better understood by regarding the situations under which they were formed.

Sankoff (2001) further explains that historically, language contact happens from imbalanced social conditions that may occur from wars, conquests, colonialism, slavery and migrations. This is based on the substratum theories that assume the assimilation of immigrants or newcomers with the native population has produced certain changes in languages spoken by these people. In this condition, conquest and immigration today are the two chief social processes that help create contact situations. In conquest, this is the case when a larger group conquers a local linguistic group; deliberate language shift happens towards generations after contacts that last for over decades or even centuries. An example can be found in post-colonial societies like Australia and New Zealand. As said by Moore (1999, as cited in Trudgill, 2008, p. 243), "with language one of the most significant markers of national identity, it's not surprising that post colonial societies like Australia, the United States, Canada and New Zealand, should want to distinguish their language from that of the mother tongue". This is caused by the "reconstructions of group identities" (Schneider, 2003, as cited in Trudgill, 2008, p. 243) by these settlers in the new lands. This means that individual members made adjustment in their everyday interaction with each other and the outsiders. These constant bilinguals lead the language assimilation where acceptance of structures from interference of the receiving language takes place. On the other hand, immigration is when newcomers adapt themselves into the existing speech community rather than setting up a new one. In this situation, linguistic assimilation is common and rapid. When the contact happens within a short duration, borrowing into the immigrant languages usually happens. Whilst in longer duration, it leads to broader structural changes of their languages.

An example of language contact outcomes from immigration is such as the Puerto Rican (Lorain Puerto Rican Spanish or LPRS) and Mexican (Mexican American Spanish) communities in Lorain, Ohio (Ramos-Pellicia, 2004). The LPRS was initially transported from rural Island Puerto Rican Spanish (IPRS). In this study, Ramos-Pellicia (2004) focused especially on the sound change. Among the findings from the phonological variation across three different generations were that LPRS still preserved the patterns of /e/ and /o/ as found in IPRS. Both LPRS and MAS were also converging in their use of /ʤ/ and diverging in their use of /r/, which varies within generation and age groups. In general, it revealed that LPRS still preserved many features transmitted from IPRS. However, due to pressures from MAS and American English speakers in this community, it is speculated that LPRS would become a dialect different from IPRS if it still survived in the future.

Further, when language contact is prolonged between groups of immigrants within a larger existing society, these groups are likely to converge with a set of linguistic norms that are unlike their previous norms. 'New dialect formation' (Trudgill, 2008) is a linguistic phenomenon shaped by a mixture of dialects by the next generations of a group of speakers in a new location, which is isolated from their ancestral homelands that leads to a single new dialect different from all inputs. Britain and Trudgill (2005) state that this condition happens due to particular sociolinguistic situations that involve contact between mutually intelligible dialects such as from colonial situations, new towns and rapid urbanisation, among others, and enables a new dialect to develop. The 'tabula rasa' theory (Trudgill, 2004) considers the conditions of this formation in three stages and corresponds generally to the first three generations of speakers as shown in Table 2.13. Trudgill further explains the tabula rasa situations in terms of colonial contexts where contact did not exist with the speakers still staying in their homeland that caused a complete discontinuance with their origin. He claims that social factors are deemed irrelevant until a new social order become known (Kerswill, 2007).

Table 2.13: Trudgill's Three Stages of New-Dialect Formation
(adapted from Kerswill, 2010, p. 234)

Stage	Speakers involved	Linguistic characteristics
I	Adult migrants (first generation)	Rudimentary levelling
II	First native-born speakers (second generation)	Extreme variability and further levelling
III	Subsequent generations	Focusing, levelling, and reallocation

At Stage I, the first generation will level away features that are in a small minority in the mix of dialects they encounter, subject to the individual's ability to do so. Trudgill (2004) states that adults are less able compared to younger speakers to modify their language, especially phonology. At Stage II, the demographic distribution of features starts to establish the shape of the focused variety that is still to turn up. At this stage, children as the first native-born speakers or the second generation linguistically parallel with the local speech, particularly that of their friends. Thus, in the context of this theory, these children are believed not to be influenced by prestige or identity marking functions. Lastly, Stage III represents the focusing of the new variety by the subsequent generations. Trudgill (2004) further argues that in Stage II and III, identity and prestige are absent. The motivation for changes, instead, is a rather automatic adjustment from direct interaction. He believes that should identity be promoted through language, then "it happens as a consequence of accommodation...Identity is not a powerful enough driving forces to account for the emergence of new, mixed dialects by accommodation" (Trudgill, 2008, p. 251).

Among the cases of tabula rasa conditions is of the early stages of New Zealand English by Trudgill and associates (Trudgill, Gordon, Lewis, Maclagan, 2000, as cited in

Kerswill, 2010). In the context of New Zealand, the new dialect formation occurred after the initial immigration of speakers came from different regions of the British Isles. From the process of dialect mixture over just a few generations, a new variety arose that was then uniform and distinct from any other existing varieties of English. Their study was based on oral history recordings of elderly New Zealanders made in 1946 to 1948 in which some were born in the period when New Zealand English was being formed around 1850 to 1890. The process of this formation considers the three stages of new-dialect formation and they believed that the accommodatory behavior and selection of linguistic variants at each stage progressed in an expected manner that is not connected with social factors except for demography. At Stage 1, the first adult migrants from different regions of the British Isles went through dialect contact with each other. At a time, they became inconsistent in their usage due to the inter- and intra-individual variability at this stage. At Stage II, the children of the first migrants picked up the unstable norm from adults, therefore, they were not influenced by prestige or identity-marking functions. Britain (2005, as cited in Kerswill, 2010) says that this was because in the early decades of European settlement, education was not compulsory and literacy was low, so the pressures from prestige did not have any effect. This came later after the children from the first generation began the process of koinéization. Stage III then focused on the new variety, where variants were reallocated to a linguistic or sociolinguistic function that was believed to form by the 1900s. The speakers contributed to the rapid change of features from origins in a range of British regional varieties. Some of the features adopted by the new variety, among others, are the retention of /h/, the maintenance of the /ʍ/–/w/ distinction (as in *which*/*witch*), the merger of unstressed /ə/ and /ɪ/ on /ə/ (as in *rabbit*), and broad diphthongs in words of the GOAT, FACE, MOUTH, and PRICE sets.

Kerswill (2010), however, argues with some conditions of the tabula rasa theory. Language change demands the current generation of speakers to innovate and adopt new features that are different from the previous generations. Thus, the new variety is believed to have emerged through numerous conscious and unconscious acts of linguistic accommodation or adjustments that are carried out by every speaker when interacting with others. Social factors, therefore, do variably play a part in the formation. For accommodation to take place, the crucial community variables are as the following (Kerswill, 2010, p. 232):

- the proportions of children to adults in the initial stage
- degree of contact within and between age cohorts, especially in families
- relations between salient social groups (to the extent that these exist in a new community)
- the degree to which social group boundaries are, or become, sociolinguistically marked
- wider linguistic ideologies
- personal and social identity formation

Furthermore, Kerswill (2010) shows that the new dialect formation, or koiné formation, is a process that is divided into several stages known as the "principles of koinéization" (Kerswill, 2010, p. 243). These principles are presented in Table 2.14. Koinéization is the "levelling of variant forms of the same linguistic items (especially phonemes and morphemes), and simplification (the reduction of phonological and morphophonemic complexity)" (Kerswill, 2010, p. 231). The process of rationalisation typically entails simplification and economisation (Aitchison, 2001 as cited in Liu, 2012) and ease of articulation in sound output. According to this ease theory, sound changes occur because of the economy of effort in producing certain sounds. This means that sounds deemed by a speaker to be produced with effort that is more physical are less favored; therefore, they are changed to those that require a lesser amount of physical effort to produce. The phonological reduction happens when there is an opportunity in the system of constraints that allow successful communication (Shariatmadari, 2006). Accordingly, the principle of minimum effort as proposed by Lindblom (1981, as cited in Shariatmadari, 2006, p. 210) is “extreme displacements and extreme velocities are avoided [by the articulatory system]” and the changes occurs within distances of two consecutively articulatory targets that requires less work. An example provided by Shariatmadari (2006) of changes due to the favor of minimum effort is the sequences /kt/ and /pt/ that becomes /tt/, and the sequence /bs/ that becomes /ss/ in Latin and Italian.

Table 2.14: Principles of Koinéization
(adapted from Kerswill, 2010, p. 243)

Outcomes in post-contact varieties: 1. Majority forms found in the mix, rather than minority forms, win out. 2. Marked regional forms are disfavoured. 3. Phonologically and lexically simple features are more often adopted than complex ones.
The migrants and the first generation of native-born children: 4. Adults, adolescents, and children influence the outcome of dialect contact differently. 5. The adoption of features by a speaker depends on his or her network characteristics.
The time scale of koinéization: 6. There is no normal historical continuity with the locality, either socially or linguistically. Most first and second generation speakers are oriented toward language varieties that originate elsewhere. 7. From initial diffusion, focusing takes place over one or two generations. Because of sociolinguistic maturation, the structure of the new speech community is first discernible in the speech of native-born adolescents, not young children.

Kerswill (2010) concludes that in new-dialect formation, social variables do variably play a part, even in Stages II and III. He noted that Mæhlum (1992, as cited in Kerswill, 2006) who studied the dialectal situation in the Norwegian Arctic territory of Spitsbergen (Svalbard) showed what children in Stage II did when there was an absence of a stable adults' or even the children's peer group model. The forming dialect was believed to be the result of identity-signalling choices made by the children. Here, the children were linguistically heterogeneous and internally not consistent as they kept on engaging in code-switching, dialect mixing, and employing strategies to set up their identification with interlocutors and situations. These strategies showed the children's linguistic adaptability to build individual identities in the unstable peer groups, which later led them to a set of linguistic norms that were collectively different from previous norms.

2.6.1.1 Reasons for Sound Change

As mentioned earlier, the four major domains of linguistics outcomes from contact are generally found at the levels of phonology, lexicon, syntax or discourse/pragmatics, and morphology/grammatical categories (Sankoff, 2001). We will now focus on the motives for these changes, particularly in sound change.

Winford (2003, as cited in Olsen, 2008) states that there is an obvious socio-environmental context in which all language contact happens and this context is important in shaping the linguistic outcome. Social factors such as age, gender, social status, among others, have been found to affect sound change as well (Thomason, 2003 as cited in Liu, 2012). Liu (2012) carried out a study on sound change in Shanghainese, a dialect of Chinese language, specifically on the development of the word *wo*, which means 'I' or 'me'. Its usual pronunciation as [ŋu:] had shifted to [u:] as a non-native alternative used by non-locals from other parts of China who migrated to Shanghai. Previously, there was negative perception of status attached to this new developed sound change by these migrants, thus, at present it was beginning to change into a positive perception. Previously, there was a lack of willingness from the local population to identify with people using [u:], but then they were starting to recognize it positively. Further, there were differences in different age and gender groups in adopting the new sound. None of the informants above 45 years simplified the pronunciation of [ŋu:] to [u:], whilst nearly all informants under 20 and between 21–25 years old used [u:]. The age groups between 26 and 45 years could be seen as a transition from [ŋu:] to [u:]. Age groups of 31–35 and 36–40 constituted a segregation block separating the old and new pronunciations. This study also suggests that social identity played a fundamental role in this adoption. As the youth in Shanghai was then adopting the non-native like pronunciation, this new sound had effectively been incorporated into Shanghainese as a variation. Since the new sound was preferred by youths compared to the old one, sound change was obviously taking shape. It was assumed that the feature of sound simplification in Shanghainese played a role in this formation. The original pronunciation [ŋu:] in Shanghainese was difficult to pronounce by non-locals who spoke other dialects as the initial sound [ŋ] did not exist in them. In contrast, the new pronunciation [u:] was easy to pronounce for most people despite of their dialect backgrounds. The local people's positive identification today with the new sound helped see this language variation become language change. Identity in this case seems to act as a filter, selectively introducing a non-native feature to be adopted by language users.

Llamas (2007) also carried out a study in Middlesbrough in the North of England on how speakers in this town define and distinguish themselves from others (in terms of the region in which they live and in terms of the accent that they have) to explain their motivation for a convergence and divergence of linguistic inclination. These include the variation in the use of glottaling and glottalization of the voiceless stops /p/, /t/ and /k/ in an urban variety of British English. Their choices and language use were further linked to the speakers' attitudinal information and their sense of identity of the area. A number of 32 speakers with a socioeconomically homogeneous group with age and gender as variables participated in this study. Interviews based on the IdQ questionnaire (to obtain information on the speakers' attitudes towards their language) were conducted. These responses provided insights into how identity works between dialect areas. Llamas (2007, p. 581) says that "within a language ideology framework, speakers' own comments about language and other social phenomena are used as a means of interpreting and understanding linguistic variation in the community, thus, allowing insight into social psychological motivations for sociolinguistic differences that may be otherwise inaccessible to the analyst". The findings showed that there was an increase in glottal stops for /t/ by the adolescents compared to those in the nearby area of Tyneside with a more traditional glottalised /t/. This variation serves to signal their local geographical distinctions. Their attitudes toward the varieties spoken nearby in Newcastle, Tyneside and Yorkshire are manifested in the construction of particular regional identities.

2.6.1.2 The Role of Identity

In language contact, speakers' choices can also pilot drastic linguistic changes (Thomason, 2007). When these changes have permanent effect in the speech community, this is due to particular social circumstances. Among the potential contributing social factors is multilingualism, language standardisers and the emergence of a new ethnic group that searches for a language to symbolize its new identity (Thomason, 2007). As stated by Spolsky (1999, p.181), "language is a powerful symbol of national and ethnic identity" as it consigns one's place and identity in the world.

However, identity and language are both dynamic in notion, depending upon time and place (Norton, 1995). They may change with the constant interactions within communities involved allowing every individual multiple identities over the years or even within a day (Gibson 2004). Therefore, language features bear social images and reveal social status of the speaker (Liu, 2012).

Appel and Muysken (1987 as cited in Liu, 2012) further say that language is inextricably tied to identity when the maintenance of a language is tied to the maintenance of the identity associated with that language. At one level, this identity consigns to being a part of particular socio-demographic groupings (e.g. age, occupation, socio-economic class, education, language and dialect background, etc) and at another level, it helps to determine how people identify their relationship with others (Milroy, 2002 as cited in Liu, 2012). Spolsky (1998) adds that the language a speaker uses is one of the most common ways of identifying his or herself. As language is inherently involved in socialization, particularly within a community speaking the same language, the language they speak is an important identity for them. Moreover, he states that there are other markers of ethnic identity such as food, clothing or religion. However, language plays a special role since it establishes social relation and a sense of belonging among speakers of the language.

Jenkins (1996, p. 4) defines identity as "the systematic establishment and signification, between individuals, between collectives, and between individuals and collectives, of relationships of similarity and difference". When a smaller group of people enters into another larger group of different nationality and language, the smaller group endures times where they would have to "define and redefine themselves and their social roles in the light of the presence of the other groups" (Schneider, 2003, p. 240). Relationships between the two groups, especially in communication, are prone to change over time where the smaller group gradually adopt and accept the larger group's linguistic norms, which eventually affect their own, and from this consequently construct a new identity (Schneider, 2003). In relation to this, King, et al. (2009) say:

> In that the sound system of a language conveys important aspects of the speaker's identity it is clear that the sort of changes likely to occur in languages undergoing revitalization will reflect important changes in the identity of new generation of speakers. (King, et al., 2009, p. 95)

Gordon (1998, as cited in King, et al., 2009), implies that it takes 30 years for members of a community to become conscious and aware of the beginning of a phonological change in their language. The aspect of pronunciation, specifically vowels, is a significant feature to look at as they bear different accents of languages (King, et al., 2009). Furthermore, vowels are not static as their dynamic properties are one of the important attributes in characterizing variants (Konopka & Pierrehumbert, 2010). From the acoustic standpoint, even the sounds of words used by a speaker are one of the forms of his or her identity. Accordingly, Jacobi (2009) explains that:

> Along with communicating meaning, the acoustic signal is a product of physical properties and changes, as well as of more generally all those factors that form the identity of the speaker, such as social affiliation or family origin. The choice of words but also the way they are realized differs from speaker to speaker, as well as within a speaker. Even more, from an acoustic point of view, each utterance is unique. (Jacobi, 2009, p. 2)

Idris, Rosniah, Zaharani, Jamilah and Mohammad (2011) claim that the relationship between language and identity is strong, therefore, even with one phonemic feature of a speaker; a listener can link his or her identity to a certain group. In relation to this, Braber and Butterfint (2008, p. 23) say that the shape of one's identity or identities, among other factors, is influenced by language and "place" or the sense of belonging to a community. Their pilot study on the local identity and sound change in Glasgow, Scotland, reveals that there is a potential link between sound change and local identity based on the speakers' sense of local Glaswegian identity and the features and changes distinguished in their English. Among these changes are the merger of /w/ and /ʍ/, the increase in T-glottaling, and the increase in the extent of l-vocalisation that are not necessarily found elsewhere in Scotland. From 12 participants, recordings were conducted in quiet surroundings on semi-structured interviews that encouraged them to talk about their feelings towards Scotland, Britain and England, Glaswegian accent, speech features and their own speech and language use. The findings show that none of the participants mentioned being British but mostly viewed themselves as equally Scottish and Glaswegian, instead. The researchers presume that the progress of the sound changes is much influenced by their strong sense of local identity.

Hence, the connection between language and identity has been observed from a variety of viewpoints over the years. Current studies on language and identity incline to observe identity as "something constructed rather than essential, and performed rather than possessed" (Joseph, 2010, p. 14). Blackledge and Pavlenko (2001) also suggest that identities are adopted by the people to be expressed rather than negotiated. Additionally, the idea that neither our language use nor our identities are stagnant prevails (Joseph, 2010; Llmas & Watt, 2010). This means that even with the speakers' identity as a whole, each of them is constantly being engaged to what Coupland defines as "the deployment of different personal identities and interpersonal images" (Coupland, 1988, cited in Bigham, 2008, p. 70). Therefore, even though a group within a community is unified under an ethnic category, individuals within it may support or challenge the expectations of their social ethnic category (Bigham, 2008) by the decisions they make for different speech events. Therefore, social identity enlightens how an individual labels himself or herself as a member of a group, ethnic group, language group, social class, nation, etc., which channels their conducts to form a collective identity (Rajantheran, Muniapan & Govindaraju, 2012).

Furthermore, minority groups that are bilinguals in character are often examined by the components of “we” versus “they” code (Gumperz, 1982, a cited in Gibson 2004, p. 5). Accordingly, “we” code signifies in-group speech that implies closeness and is mostly limited to the home, family bonds and informal activities conducted within the in-group members. Whilst “they” code carries a higher prestige by the larger group and is associated to the socio-economic progress, formal situations and less personal out-group relations. An example provided by Gibson (2004) is the Spanish speakers in the U.S. They may choose to speak Spanish to imply their difference from the dominant group, while simultaneously creating solidarity with other Spanish speakers. It becomes the symbol of solidarity and identity marker for the Spanish-speaking community.

2.6.2 Language and Identity in Malaysia’s Multiethnic Society

Malaysia is known for its rich multilingual and multiethnic population. The diverse community in Malaysia is increasingly portrayed by migration and contact between different ethnic groups, cultures, dialects and languages. Malay, though, is the national language of Malaysia and English is a compulsory second language in all government schools (Sankar, 2011). Therefore, the mastery of these two languages is important for academic achievements and for a successful future. It also represents the language of economic and social mobility in Malaysia (Sankar, 2011). This country is basically comprised of many ethnic groups that encompass Malays, Chinese, Indians and other minorities and indigenous people. As reported by Sankar (2011), the population of Malaysia is ethnically and linguistically heterogeneous comprising of Bumiputra

(65.1%) of whom Malays are the majority, Chinese (26%), Indians (7.7%) and other ethnic groups. Therefore, this country is multi-ethnic, multi-cultural and multi-lingual.

As observed by Hoffman (1991, as cited in David, Dealwis & Alagappar, 2011), in the case of migrant or minority communities, its members might opt to change one set of linguistic tools for another due to certain cultural, social and political conditions in the country that they are residing in. Thus, when competition arises from a regionally and socially more powerful or numerically stronger language, language maintenance and shift occurs (David, Dealwis & Alagappar, 2011).

A number of studies have also been carried out on minority language users in Malaysia. Among them are studies by David (1998), who studied the use of Sindhis among Malaysian Sindhis community and discovered that the community was simply not large enough to maintain the use of Sindhi in Malaysia. Mohamad (1998) studied the Javanese of Sungai Lang, Malaysia, and claims that most of the parents in that particular area strongly believed that it was unnecessary to passed down the heritage language to the younger generation as this language would not bring them any ease at school and social life outside of the community. Jariah (2011) also found a similar situation on another Javanese community in Kampung Jawa, Hulu Langat, Malaysia. They were originally from Kebumen and Banyumas in central Java who entered Malaysia about one hundred years ago. It was found that for some communities who were Muslims in Malaysia, such as the Javanese community in Kampung Jawa, it was important for them to become Malays. Therefore, the Javanese community incorporated with the Malays and changed to the national language. Over the years, not every Kampung Jawa residents maintained their language of origin, Javanese, in their interactions. This was evident especially among the younger generations. Only the first and second generation still maintained attachment to their heritage language and background. The construction for a Malay identity was important for their economic survival as this identity eased their access to Malay privileges in the country. However, despite having a new identity to assimilate with the Malays, they still preserved some aspects of their Javanese culture: in their food (such as *nasi ambang, sambal goreng, pecal, tempe* and *ikan bakar*) and music (such as *kompang, silat* and *wayang kulit*). They demonstrated signs in which being Malaysian rather than being Javanese was more apparent. It is believed that this community is now experiencing language shift (David, 1998). This is the case where the community's former mother tongue, Javanese, has been replaced by the younger generation with a language that has a higher social position in the community, which is Malay.

As for Acehnese descents in KpA, Kedah, continuous interactions in Malay and Kedah dialect within the predominantly Malay community have led to increasing bilingualism among this minority at home. Also with the additional mixed marriages that are occurring between Acehnese descents and Malays in recent years. Acehnese in the village only occupies the role of a heritage language as its use is generally limited to within the family in the home and village, but not to a larger society outside of the village. Yusuf, Pillai and Mohd. Ali (2013) further report that Acehnese only becomes dominant in the home if the mother is of Acehnese descent. Thus, as mentioned in 1.4.2, Acehnese descents in KpA still maintained their Acehnese through their presentation of identity by claiming themselves to be Acehnese.

Trudgill (1974, as cited in Tan, 2012) says that the different identities of ethnic groups can be indicated by the use of different varieties of the same language. Particular characteristic linguistic features from each of these varieties function as the group-identification tool for every ethnic group. A study by Tan (2012) that investigated the identification of ethnicity in speakers of Singapore English on the basis of voice quality from three ethnic groups (Chinese, Malay and Indian) from informants of different age groups found that there were differences among these age and ethnic groups. The older generation (aged 50-65) had better accuracy in identifying different accents compared to the younger generations (aged 30-49 and 19-29) due to their longer exposure and experience towards speakers of different ethnic groups. Thus, the youngest generation in the study did not identify well the different accents and the author attributed national policies to perhaps be the cause of this 'deafness' (p. 569) where natural policies build a sense of national identity rather than ethnic identity. Therefore, they recognised every voice that were deemed to them without any distinguished features as a national Singaporean accent, or 'Chinese' accent as this community is the dominant one in the country (p. 582), rather than an ethnic one.

However, in the argument of ethnic identity, previous literature revealed that language is not a compulsory requirement to identify with an ethnicity in Malaysia (David, Dealwis & Alagappar, 2011; Pillai & Khan, 2011; Sankar, 2011). Sankar (2011), for example, finds that despite the second and third generations of Malaysian Iyers using more English than Tamil, this does not signify that they have lost their ethnic identity as they believed that it is still maintained through their cultural and religious practices. A study by Eastman and Reese (1981, as cited in Gibson, 2004) also pointed out that an Irish may identify himself or herself as Irish even though they do not speak Gaelic. Indeed, an individual that belongs to a certain ethnic group may have a symbolic attachment to its associated language, but may use another language that is more effective in his or her community at large.

2.7 Conclusion

This chapter has presented a review of Acehnese vowels, SM vowels, and KD vowels, the review of acoustic phonetics in relation to vowel studies, and on language contact and identity. The Acehnese vowels described by Asyik (1987) thus far provides the most complete inventory of the vowels. Presently, there is a paucity of studies on the realization of vowel qualities by Acehnese speakers spoken in and outside of the province. Therefore, this study attempts to fill this research gap. Since this study focuses on the sound change that is occurring in the Acehnese spoken by Acehnese descents in KpA, further analysis of the vowels occurring in SM and KD and their possible influences are presented in the following chapter.

The formant frequency model is an intensely used method for measuring and analysing vowel qualities. This chapter has presented the ways previous studies measured and analyzed monophthongs and diphthongs in various languages. Furthermore, it has highlighted the approach of collecting data, such as from citation and spontaneous speech. The advantages and setbacks of these two approaches are also mentioned.

To further explain the sound change and maintenance in the Acehnese spoken by Acehnese descents in KpA, this chapter has also presented a review of literature in the domain of language contact. The results of language contact are known to produce linguistic changes in a minority language that is spoken among a dominant one. There are various studies that justify the causes of sound change and or maintenance. These changes and maintenance are related to historical reasons, social status, ease of articulation, age, education, employment, and identity. The following chapter describes the methodology used in this study.

CHAPTER 3 : METHODOLOGY

3.1 Introduction

This chapter describes the methodology employed in the data collection and analysis of this study. The profile of language consultants, data that consist of Word Elicitation (WE) and Interview (INT), process of data collection (venues and instrumentation) and analysis conducted for the monophthong and diphthong measurements are provided.

3.2 Language Consultants

In this present study, there were four groups of speakers who were recorded to collect data. The first two groups consisted of Acehnese speakers from Ach and speakers from KpA. As the study also sought to find out the possible influences of SM and KD vowels on Acehnese vowels produced by speakers in KpA, the third and fourth groups included speakers of SM and KD.

3.2.1 Ach and KpA Language Consultants

The language consultants included 20 female speakers, ten each from Ach and KpA. Ach language consultants were native speakers of the North Aceh dialect and lived in Lhokseumawe in the North Aceh Regency as did the speakers in the studies by Asyik (1972, 1987). As this study used Asyik's vowel inventory as a basis to construct the word list for target words to collect the Acehnese vowels, speakers in Ach were also chosen from this dialect. The average age of these language consultants was 54 years (ranging from 45-60 years old with a standard deviation of 4.9 years), and all of them had at least a secondary level of education (SMA – Sekolah Menengah Atas). The reason for selecting this age group was that the younger age groups tend to use more Bahasa Indonesia (see the discussion in 1.2).

Some important categories for the selection of Ach language consultants were that: firstly, even though they were fluent in Bahasa Indonesia, they spoke the North Aceh dialect as their first language, and secondly, they used it at home with their family and community members in informal contexts. An Acehnese language teacher, who was also a speaker of the North Aceh dialect, helped to identify language consultants who fit these criteria, and eventually ten language consultants were selected who consented to participate in the study (see Appendix F for the letter of permission to conduct research for the language consultants). Five of the language consultants were housewives, four were teachers and one was a businesswoman who managed a travel agency. In this study, they were coded as Ach1, Ach2 and so forth to Ach10. Table 3.1 presents the profiles of language consultants in Ach.

Table 3.1: Profiles of Ach Language Consultants

Codes	Age	Occupation	Origin/Address
Ach1	50	Housewife	Lhokseumawe
Ach2	54	Housewife	Lhokseumawe
Ach3	60	Housewife	Lhokseumawe
Ach4	54	Housewife	Lhokseumawe
Ach5	50	Teacher	Lhokseumawe
Ach6	55	Teacher	Lhokseumawe
Ach7	45	Teacher	Lhokseumawe
Ach8	60	Housewife	Lhokseumawe
Ach9	60	Businesswoman	Lhokseumawe
Ach10	56	Teacher	Lhokseumawe
Average	54.4		
SD	4.9		

KpA language consultants were coded as KpA1, KpA2 and so forth, to KpA10. They were all from the 4th generation of Acehnese descents, and similar to Ach speakers, the average age of these language consultants was 54 years (ranging from 46-60 years old with a standard deviation of 5.5 years). This group was chosen because they had acquired Acehnese as their first language and use it extensively with family members and fellow Acehnese in the village. Based on the feedback obtained from Acehnese descents in KpA during the survey in August 2008, men and women from the fourth generation had only learned Malay when they first started primary school at the age of seven. From the fifth generation onwards, they had started to acquire Malay and Acehnese bilingually as their first language, and the younger generations generally speak more Malay (see Yusuf, Pillai & Mohd. Ali, 2013).

Only females were selected to obtain data for this study because of restriction in the availability of the males in this age group during data collection. Most of the males worked outside of the village, such as in the nearby areas of Yan Kechil, Yan Besar, and Guar Chempedak and even Alor Star. They would leave the village early in the morning and return in the evening. However, most of the women in this age group worked in the village as cooks, tailors, teachers and housewives. Only a few worked outside of the village. Therefore, it was more convenient to get in contacts with the females compared to the males, and they were also less likely to be influenced by other languages.

The manager and secretary of KAMC (Kampung Aceh Management Center) in the village helped to select the language consultants for this study. There were about 16 females who resided in the village during data collection for this study, aged between 41 to 60 years old (4th generation). From these women, only 10 consented to be recorded for this study. The language consultants were all educated at least up to secondary level (SPM – Sijil Pelajaran Malaysia). A majority of Acehnese descents in KpA from the third and some from the fourth generation completed their secondary school in English-medium schools, whilst the younger generation went to Malay-medium schools. For the language consultants, two (both age 60) had attended the English medium schools, three (age 57-58) had started their primary level in English medium schools but then continued their studies in the Malay medium schools, and five (age 46-55) had attended the Malay medium schools. Three were tailors, one was a teacher in a secondary school, one was a cook, one was a secretary in KAMC, one was an administrative officer in a government office and three were housewives. None of the language consultants reported having any hearing or speech impediments. The profiles of language consultants in KpA are presented in Table 3.2.

Table 3.2: Profiles of KpA Language Consultants

Codes of the KpA Consultants	Age	Occupation	Origin/Address
KpA1	46	Secretary in KAMC	Kampung Aceh
KpA2	46	Cook in a stall	Kampung Aceh
KpA3	55	Housewife	Kampung Aceh
KpA4	57	Administrative officer in a government office	Kampung Aceh
KpA5	54	Tailor	Kampung Aceh
KpA6	60	Tailor	Kampung Aceh
KpA7	51	Teacher in a secondary school	Kampung Aceh
KpA8	60	Tailor	Kampung Aceh
KpA9	60	Housewife	Kampung Aceh
KpA10	50	Housewife	Kampung Aceh
Average	53.9		
SD	5.5		

3.2.2 SM and KD Language Consultants

The additional language consultants for comparable data were of SM and KD speakers, who comprised 6 females with 3 from each group. To keep the gender variable consistent with the language consultants in Ach and KpA, only females were selected for analysis. The speakers selected for KD were assumed to be proficient in their dialect as they were born and raised in Kedah. They acquired this dialect as their L1 at home.

The speakers of SM were also assumed to be proficient in this dialect as they had acquired it as their L1 at home.

The SM language consultants were considered as speakers of Standard Malay and had lived in the Klang Valley until the age of 15. The KD language consultants were native speakers of the Kedah dialect and had lived in Alor Star, Kulim and Pendang in Kedah until the age of 15. The average age of the SM language consultants was 31.6 years (ranging from 25-38 years old with a standard deviation of 6.5 years), whilst the average age of the KD language consultants was 24.6 years (ranging from 24-25 years old with a standard deviation of 0.6 years). The language consultants from these groups were students or working adults. All language consultants had no hearing or speech problems. The profiles of these language consultants are presented in Table 3.3 for SM and Table 3.4 for KD.

Table 3.3: Profiles of SM Language Consultants

Codes of the SM Consultants	Age	Occupation
SM1	32	Administrative officer in a government office
SM2	25	Administrative assistant in a government office
SM3	38	Administrative officer in a government office
Average	31.6	
SD	6.5	

Table 3.4: Profiles of KD Language Consultants

Codes of the KD Consultants	Age	Occupation
KD1	24	Student
KD2	25	Student
KD3	25	Student
Average	24.6	
SD	0.6	

Before the recording session started, every SM and KD language consultant provided information about their background and signed the consent form as presented in Appendix G.

3.3 Data

Data were collected in two speaking contexts: data from elicited speech or WE and data from spontaneous speech or INT. The two contexts were chosen because WE helped to ensure that the entire target sounds were provided, whilst INT complimented WE by presenting the vowel segments in other similar environments from a more natural approach.

To elicit the target vowels for WE, a word list was designed. As discussed in 2.5.1, word lists are widely used to obtain vowel data for acoustic analysis, and the rationale of word list is to control the phonetic environment for the vowels under investigation. Another justification for employing such technique is to ensure that all target sounds are presented. To collect vowels for INT, informal interviews were also conducted to elicit more spontaneous speech production. As Deterding (1997, p. 54) says “connected speech represents somewhat more natural data than the rather artificial vowels derived from specially articulated citation speech”. As this study is the first one to describe the Acehnese vowels used in KpA, specifically, it was important to collect data from both contexts to observe their productions. Further advantages and restrictions from both contexts are explained in the following 3.3.1 and 3.3.2.

3.3.1 Data for Word Elicitation

The following sections present the word list used to extract the Acehnese vowels and the manner of elicitation during data collection.

3.3.1.1 Word List

The target words for WE were chosen from the list of Acehnese words with vowels proceeding and following stops or fricatives in a CVC or CV environment, as recommended by Tsukada (2008) and King (2006). To avoid effects of adjoining sounds, nasals, liquids and approximants were excluded. Ladefoged (2003, p. 122) also informs that “slight nasalization will affect the spectrum by introducing resonances associated with the nasal tract”. This, for example, can be seen in Figure 3.1 on the differences of the formants in the vowel /e/, which appears following a nasal in *péng* ‘money’ and the one following a stop in *pét* ‘shut (the eyes)’ in Acehnese.

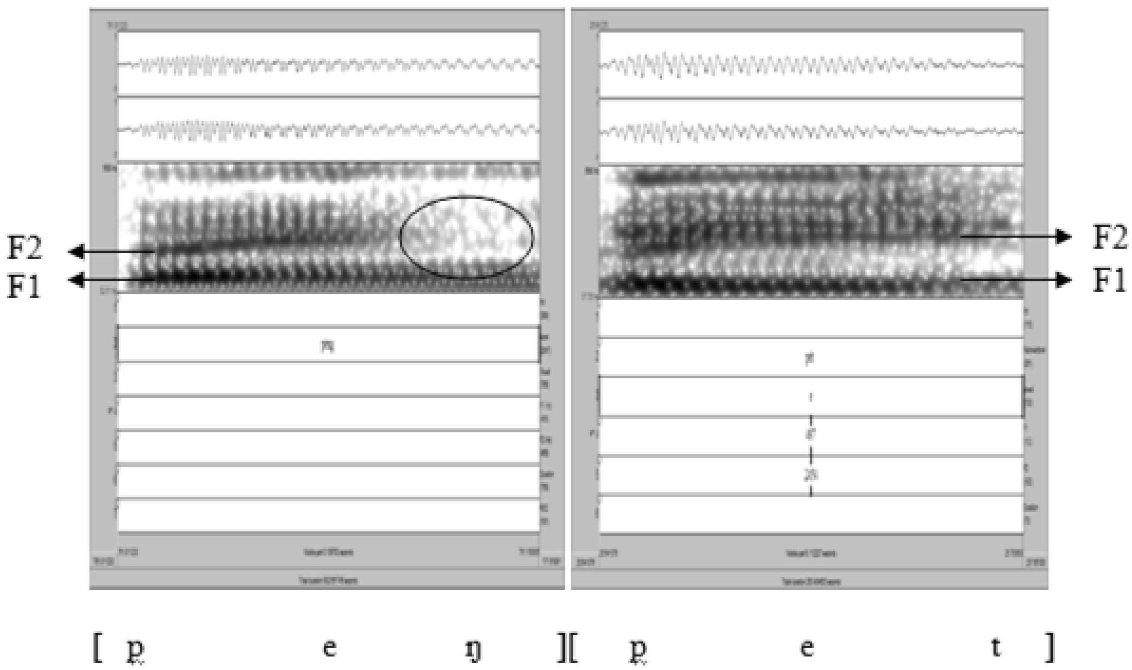


Figure 3.1: Spectrograms of the vowel /e/ in *péng* (left) and *pét* (right)

In Figure 3.1, the second formant of /e/ is seen to weaken following the nasal /ŋ/ in the word *péng*. This is because there is interference in between as the nasal /ŋ/ produces more anti-resonances that reduce formants at or near these frequencies (Hagiwara, 2009). This causes it to appear faint or absent in the spectrograms such as indicated by the circle. As a result, the LPC does not work properly in detecting the formants for nasal vowels (Boersma & Weenink, 2007). In *pét,* the first and second formants of the oral vowel are easily recognized, which allows the formant tracking program to better identify the formants. Furthermore, the target words used for this study were words with vowels following stops or fricatives to obtain better measurements of the vowels.

The monophthongs were all extracted from closed syllable words in the CVC environment where C was stops, stop consonant clusters with /h/ such as /ph/, /ch/, /kh/, /bh/ and /dh/ (see Asyik (1987) on Acehnese consonant clusters) that only appear in the initial positions in the words rather than in the finals, and fricatives. Acehnese stop consonants comprise nine stops, which are the voiceless stops /p/, /t/, /c/, /k/, /ʔ/ and the voice stops /b/, /d/, /j/, /g/, and the fricatives are /f/, /s/, /ʃ/ and /h/ (Asyik, 1987; Durie, 1985). As for diphthongs, they were extracted in CV and CVC environment, depending on where the diphthongs typically occur. As mentioned in 2.3, Acehnese vowels can occur in both closed and open syllables. However, for /ɛə/ and /ɔə/ as well as /əi/, /ui/, /ʌi/, /oi/ and /ai/, they only occur in open syllables. As /ʌi/ only appears in the word *lagöina* as mentioned in 2.3, this word is the only choice for /ʌi/.

Ach language consultants, Ach5 and Ach10 from personal interviews in December 2012, also claimed that they, too, rarely used *lagöina* in their daily speech. However, this word was still common for their parents (those born in the 1920s-1930s) and used daily or by relatives who resided in rural villages such as in Teupin Mane, Aron, Cot Peuték and Blang Keureuleuh, all situated in the North Aceh region. *Lagöina* is occasionally used to refer to anything that is extreme in appearance or normality. Some examples provided by Ach10 include *si dara nyan ceudah lagöina* 'that girl is very beautiful' and *bagah lagöina di ba-plueng moto nyan* 'that car was driven really fast.'

At present, words such as *that* instead of *lagöina* are used more often to express the meaning of 'very'. This was also evident from INT collected from Ach language consultants who had all used the word *that* to convey 'very' in their speech instead of *lagöina*. An excerpt from Ach2 in the use of *that* from INT recording is as the following. E refers to Excerpts from the interviews, and, therefore, E1 is excerpt one and so forth. The transcription conventions are adapted from Giampapa (2001) (see Appendix B):

(E1) *Hana peu lagak lagak* ***that*** *aré 'öh?* 'It doesn't have to be **very** beautiful, right?'
[Ach2 from INT at recording time: 1065.15 sec to 1066.45 sec]

The lesser use of *lagöina* was also apparent during INT collection (see 5.3.3.10) where the language consultants from both Ach and KpA had difficult times answering the probing questions to elicit /ʌi/ in *lagöina* from: *peu kata laén keu 'that', lagèe lam 'lagak that that'?* 'What is another word for 'very', such as in 'very, very beautiful'?' However, when the interviewer said some parts of the *Bungong Jeumpa* lyrics: *lam lagu Bungong Jeumpa, bungong nyoe dikheun indah...* 'In the song, *Bungong Jeumpa*, this flower is said to be ... beautiful', then they could all finish the sentence by producing *lagöina*. This song was still popular in KpA because the language consultants said that their elders had passed down the song to them.

Personal telephone interviews with Ach5, Ach8, Ach9 and Ach10 on December 17, 2012, suggest that another word commonly used these days to mean 'very' is *keudéh* and *leupah*. Instead of 'very', *keudéh* has another meaning that is 'over there, there'. Similarly, another meaning for *leupah* is 'something that has happened or passed'. Numerous examples of *keudéh* 'over there, there' and only one for *leupah* (from Ach3) were found in INT, unfortunately none of *keudéh* and *leupah* with the meaning of 'very' were found. Thus, examples commonly expressed provided by Ach8 are such as:

(E2) *Brok keudéh.* 'Very ugly'.

(E3) *Trép keudéh bak ta prèh.* 'We waited very long'.

(E4) *Leupah raya badan jih*. 'His body is very big'.

(E5) *Kuah pliek nyoe leupah mangat*. 'This *kuah pliek* [traditional Acehnese gravy dish] is very delicious'.

[Ach8, personal communication in December 17, 2102]

It is also assumed that *lagöina* is being less used by the Acehnese today because its synonyms *that*, *keudéh* and *leupah* have fewer syllables, which leads to simpler articulation. It causes the speakers to use these two words more commonly compared to *lagöina*. Ach10 further suggested that she rarely used *lagöina* because:

(E6) *Hèk that bak ta-kheun, panyang that* (laugh) *'that' mangat, paneuk.* 'It is tiring to pronounce it, it is too long (laugh), '*that*' is easier, it's short.'

[Ach10, personal communication in December 17, 2102]

As for the sound /ɔi/, the word *poih* was chosen over *boinah* because Ach language consultants in this study maintained that despite *boinah* being still used by the Acehnese, it is being replaced by its synonym *areuta* or *atra*, which is borrowed from Bahasa Indonesia, *harta*. E7 is an explanation given by Ach5 on the use of *boinah* today.

(E7) *Nyoe/kata nyan mantong ureueng kheun, man jinoe leubèh ramè ureueng kheun areuta/atra//mungkén sebab lam basa Indonesia di kheun* harta *jadi ladôm ureueng bagah meuphôm meunyo ta kheun areuta daripada ta kheun boinah/meunyo ureueng-ureueng syik lôn tapi memang mantong geu ngui nyan boinah.* 'Yes/that word is still used/but today many people say *areuta/atra*//maybe it is because in Bahasa Indonesia it is harta so some people will understand quicker if we say *areuta* rather than *boinah*/But my parents (born in the 1920s-1930s) still use *boinah* (in their daily Acehnese).'

[Ach5, personal communication in December 17, 2012]

Thus, *poih* is still commonly used for 'mail, post' in daily Acehnese. This word is borrowed from Bahasa Indonesia, *pos*, with similar meanings.

3.3.1.2 Manner of Elicitation

The target words were common words and selected with reference to words samples provided in dictionary entries (Hanafiah & Adam, 2000; Daud & Durie 2002) and example of words provided in the studies by Asyik (1987), Durie (1985), Sulaiman, et al. (1977), and Wildan (2002). The words were all single syllable words, except for *lagöina* to extract the sound /ʌi/. This is due to the fact that this sound is only found in this word as discussed earlier in 2.3. The word list for target words selected to extract the vowel sounds in this study is provided in Appendix C.

Each language consultant was interviewed one at a time and single words were obtained in the manner of a quiz. The language consultants were to provide the target word from the word list. They were not asked to read the target word in a series of sentences as conducted by some studies as discussed in 2.5.1 because Acehnese for the most part is used in a spoken rather than a written form. For KpA language consultants, specifically, Acehnese is not taught officially but is passed on orally from the elders to the young generation. Most importantly, the focus was on obtaining a more naturalistic speech production (see Ladefoged, 2003), and by conversing with the language consultants rather than just getting them to read sentences or words, it is hoped that this naturalistic approach was accomplished.

Images (see Appendix D) were used to further assist quick and correct elicitation of the target word from the language consultants. Most of the words were nouns and verbs and could be represented in pictures. The images were retrieved from www.fotosearch.com. Every picture for the target words was glued onto a cardboard of approximately 6cm x 10cm for viewing convenience of the language consultants. The means of providing images was to act as a stimulus for the language consultants to produce the target words. This is considered by Ladefoged (2003) as a useful elicitation technique. Further, this method was to obtain the target vowels through natural production as the speakers' concentration would be more on the answer rather than on controlling their pronunciation (Walters, 2006).

Probing questions were also used to lead the language consultants into producing the correct target word if they did not produce it in the first instance (e.g. *Peu ta kheun nyoe?* 'What do we call this?' or *Kata laén jih?* 'What is another word for this?'). The questions were particularly helpful with target words that were not obviously represented by the pictures, such as *cit* 'too, also' and *kèe* 'the informal/impolite form of I, me and mine'. For example, for the word *kèe*, the language consultants were shown a picture of a man pointing to himself (see Figure 3.2). In the North Aceh dialect, the impolite form of 'I' is used when communicating among peers, but it can also be used when a person is angry and wants to emphasize something. To trigger the expected response, the language consultants were asked: *Aci eu ureueng agam nyoe, geu tunyok droe-geuh: ‘lôn’. Peu kata laén keu ‘lôn’ tapi lam bentuk kureueng sopan*? ‘Look at the man; he is pointing to himself indicating: ‘I’. What is another impolite form of ‘I’?’ Another example is when obtaining the noun *bhôi* [bhoi] ‘sponge cake’. The speakers were shown a picture of a sponge cake and asked: *Peu nan kuéh nyoe?* ‘What is the name of this cake?’ When the language consultants had presented the correct answer, they were asked to repeat the target word three times at a normal speaking rate.

Figure 3.2: Samples of images to assist the words *kèe* (left) and *bhôi* (right)

3.3.2 Data for Interview

Ladefoged (2003) and Van Heuven, Edelman and van Bezooijen (2002) proposed that natural pronunciation is better obtained by prompt conversation rather than by having the speakers read a list of words because they may read them with a different pronunciation from their normal speech. Consequently, INT was also conducted to supplement WE. The interviews were conducted informally to obtain spontaneous conversation. During these sessions, the researcher was involved in a conversation with the language consultants to get them to talk. The situation could be described as spontaneous dialogue between the researcher and language consultants.

Every language consultant was given approximately 15 minutes for the interview. The main topic discussed was the tsunami that hit Aceh on December 26, 2004. There were also nine pictures that were provided to assist them to talk about their experiences (see Appendix E). The rationale of presenting pictures to the language consultants was to encourage them to speak and such a technique was utilized by Lee and Lim (2000) and Walters (2006) to elicit vowels produced in spontaneous speech.

The opening question of the interview was about their feelings and experiences during the earthquake and tsunami disaster. Before recording sessions started, they had given prior permission to discuss this topic. This topic was quite motivating for Ach language consultants to keep talking as they all had experienced the event. Even though they were from Lhokseumawe, when the disaster occurred they were all in Banda Aceh due to the pilgrimage season. They had gone to visit their children or relatives who were to leave for Hajj. Furthermore, they all had a second home in that city. As they could relate to the catastrophe, most spent more than 15 minutes describing their experiences. The total recording time for the interviews from Ach language consultants was approximately 2 hours and 47 minutes and 17 seconds.

Nevertheless, KpA language consultants did not directly experience the disaster. Therefore, they could only relate to how they felt about it or relate the tragedy encountered by their relatives in Aceh. This topic took up approximately the first 3-7 minutes of their interview time. The pictures provided did assist them to further convey their thoughts and stories. Hence, further questions were asked on the use of the Acehnese language in their households and village, and on Acehnese food and culture that were still maintained by their families. The total recording time for the interviews from KpA language consultants was approximately 3 hours and 2 minutes and 26 seconds.

The selection of vowels in words from INT was similar to WE, where the monophthongs were elicited from words with closed syllables in a CVC environment, and diphthongs were extracted in CV and CVC environments, depending on where the diphthongs typically occur, where C is stops, stop consonant clusters with /h/ and fricatives. This was to avoid co-articulatory effects on the vowels from specific environments. Words selected were those that were articulated clearly by the language consultants where the formants of the vowel segments were apparently visible to be measured. The measurement of a vowel was excluded if it fell under one of the following tribulations:

- mispronounced words due to rapid speed of speech
- words accompanied by too much background noise (e.g., ringing mobiles (even though they were asked to turn their mobile phones off before the recording), cars passing by and animal noises outside of the room (chicken, birds or monkeys such as the case in KpA recording sessions)
- words accompanied by laughter or other mimic expressions from the language consultants
- vowels produced less than 0.01 sec long (Bigham, 2008) as this is deemed to be too short for analysis.

Further, INT provided wider possibilities for language consultants to produce the target vowels in other meaningful words, thus, still within stops and fricatives in CVC for monophthongs and CV or CVC for diphthongs, instead of just the word list prepared for WE. It had also enabled the attainment of more complete vocal sounds, especially for a language that has not been researched comprehensively before in the field of phonology such as the Acehnese spoken in KpA.

3.3.3 SM and KD Data

As comparable data was needed to explain possible influences of SM and KD vowels on Acehnese vowels produced by KpA language consultants, the data from these groups of speakers was only selected from one set of data, in the form of elicitation. Due to the time and funding limitation of this study, no further interviews were conducted as the word elicitation was expected to be enough to conduct the comparisons. The target words for SM were chosen with reference to word samples provided in Kamus Dewan (2005), and the target words for KD were selected with further reference to word samples provided in Ismail, et al. (2002). Similar to Acehnese word list, the vowels with adjoining nasals, liquids and approximants were avoided to avoid co-articulatory effects from these vowels. These words were also chosen because they are commonly used by the speakers.

The target vowels of SM and KD were embedded in words with a CV context where C is a stop consonant. These vowels are placed in a carrier sentence:

Sebut CV tiga kali ‘Say CV three times’

The language consultants were asked to read these sentences in sequential order. The word lists for SM and KD that were used to analyze their vowels can be found in Appendix H for SM and Appendix I for KD.

3.4 Data Collection

The data from WE and INT for Ach language consultants was collected in Banda Aceh, Indonesia, from September 24, 2009 until September 30, 2009. The data from WE and INT for KpA language consultants was collected in Kampung Aceh, Kedah, Malaysia, from December 19, 2009 until December 24, 2009. The data from SM and KD language consultants were collected in Kuala Lumpur, Malaysia, from March 18, 2013 until March 21, 2013.

3.4.1 Venues

The recordings of Ach language consultants were conducted in a soundproof room in the Acoustic Laboratory, Faculty of Chemistry Engineering, Universitas Syiah Kuala, in Darussalam, Banda Aceh (see Figure 3.3).

Figure 3.3: Recording in Banda Aceh

Each recording session with every language consultant started with some note taking to obtain their background identification. The date and time of recording, the name of language consultant, age, occupation, contact number and address were included in the notes.

As for KpA language consultants, the recordings were conducted in a quiet room in Kampung Aceh. The setback with the recording here was that there was no soundproof room available in the village, but this was an expected situation in field recording. Ladefoged (2003, p. 21) says “to make a good recording is to reduce background noises as much as possible”. These also include a number of electrical items such as the gas stove, refrigerator, electric fans and air conditioner (Ladefoged, 2003; Plichta, 2010). Following this, the manager and secretary of KAMC, and the chief of the village, permitted the use of Dewan Kenangan Sabena Koperasi in the village, which is a room in a small building that functions as the villagers meeting corner. It was a 4mx10m meeting room and located 10 meters away from the main road. The doors and windows were covered with polystyrene foam to minimize noise from outside. To further reduce background noise, the foam is also tightly sealed with an additional layer of transparent plastic (see Figure 3.4). The use of a head worn microphone also minimizes background sounds.

Figure 3.4: Dewan Kenangan Sabena Koperasi in Kampung Aceh

Lastly, language consultants of SM and KD were recorded in a quiet room at the University of Malaya in Kuala Lumpur.

3.4.2 Instrumentation

The language consultants were recorded on site using the Marantz PMD661 Solid State Sound Recorder with a built-in Audio-Technica ATM73 head-worn microphone. When noises are unavoidable in the recording site (such as in the case of KpA in this present study), Ladefoged (2003) suggests the use of head-worn microphone because this close-talking microphone will capture most of the speaker's voice. Ladefoged (2003, p. 22) further explains that "chickens or cars that are 10 m away will not be a problem if the microphone is only 2 cm from the speaker's mouth". Plichta also (2010) suggests that a head-worn microphone will achieve the highest signal when it is placed from the speaker's lips at about 3-6 cm and a little off to the side of the mouth to keep away from the direct rush of air in fricatives and stop bursts.

Figure 3.5: Recording sessions in Banda Aceh (left) and Kampung Aceh (right)

To assure quality recordings, they were sampled at 44,100 Hz at a 16 bit sample rate. The software PRAAT version 4.6.12 (Boersma & Weenink, 2007) was used to analyze the data.

3.5 Data Analysis

Every saved WAV file was coded as WEAch1 until WEAch10 for the WE recordings and INTAch1 until INTAch10 for the INT recordings of Ach language consultants, respectively. Likewise, KpA language consultants' recording files were coded as WEKpA1 until WEKpA10 for the WE recordings and INTKpA10 until INTKpA10 for the INT recordings. Furthermore, SM language consultants were coded as SM1 through SM3, and KD language consultants were coded as KD1 through KD3. Labels and segmentation of the speech waveforms were specified by using the TextGrid Function in PRAAT. From this function, tiers were created for Interviewer, Language Consultant's code, Vowel, F1 (Hz), F2 (Hz) and Duration (see Figure 3.6).

The Interviewer segment was the orthographic transcriptions of the interviewer's speech, while the Language Consultant's code segment was the orthographic transcription of the language consultant's speech. The Vowel segment was the extracted vowel sound from the target word said by the language consultant and annotated in its IPA symbol. Despite Acehnese monophthongs not being discriminated by length (Asyik, 1987); this study measured all vowel length to study the differences in their production from the two speaking contexts. The duration was also important for the diphthong measurements to measure the ROC values. In the F1 (Hz) and F2 (Hz) segments, these first and second formants were measured based on the LPC formant tracks. The waveform and spectrogram of the word *peut* 'four' from an Ach language consultant with labels and segmentations is displayed in Figure 3.6.

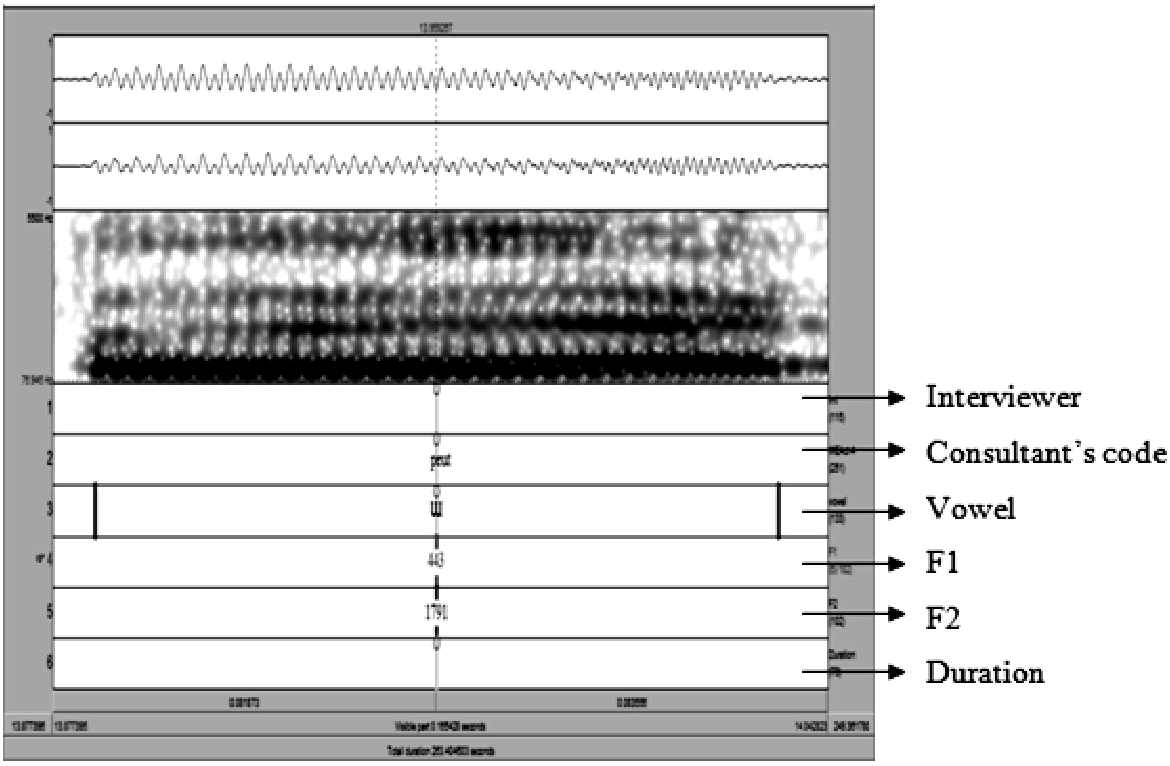


Figure 3.6: A screenshot of waveform, spectrogram and annotation from peut

The view range of 5500 Hz was set for the spectrographic display in PRAAT because this is the frequency range that is generally adjusted for female speakers (Chen, 2008;

Ladefoged, 2003; Nowak, 2006). The dynamic range, which determines energy thresholds that PRAAT recognizes for its spectral analysis, was set at 40 dB as suggested by Plichta (2010), with the window length of 0.005 seconds.

Automatic formant measuring provides formant values by the use of LPC analysis overlaid on digital spectrograms. Nonetheless, as described by Harrison (2004) and Jacobi (2009), measuring formants by using this method is not very accurate because sometimes the LPC do not produce accurate readings, and this was also the case for this study. Therefore, the formant frequencies for every vowel were re-measured manually to reassure proper measurements. The data measurements were then entered into separate Excel files labelled as WE DATA and INT DATA. Here, the values of F1 and F2 in Hertz for each vowel were then converted to Bark scale as presented in Equation 2 (see 2.5.2). No normalization for vocal tract length was conducted since all language consultants were adult females (Konopka & Pierrehumbert (2010).

Statistical analysis was performed using independent samples t-tests on the measurements of both monophthongs and diphthongs from WE and INT. The t-tests were conducted to compare and determine whether the target vowels were produced with similar or different qualities by Ach and KpA language consultants. The online calculation of statistical quantities was done in the VassarStats: Website for Statistical Computation, created by Richard Lowry (1998-2013).

3.5.1 Monophthong Measurements

Monophthong vowels were determined by measuring the F1 and F2 at a point approximately in the middle of the segment where the formants are the most steady (Ladefoged, 2003), a method that is commonly used in acoustic studies (see 2.5.2). F1 is known to be related to vowel height while F2 is related to vowel frontness/backness and rounding. Figure 3.7 shows the midpoint measurement of a monophthong from the word *peut* 'four.'

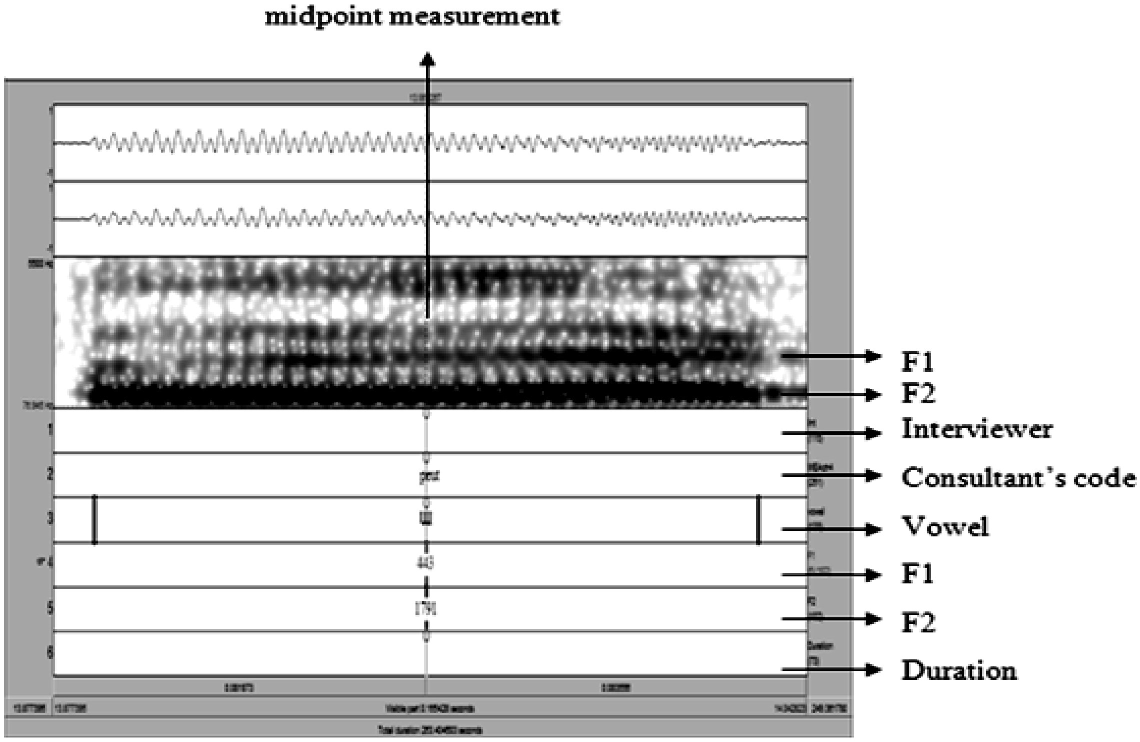


Figure 3.7: Example of vowel measurement

Next, the vowel quality was represented in the formant plot of F1 against F2. The Euclidean distance was measured to observe the average distance of the vowels from the center in the vowel space (see 2.5.1). This was done to compare the shape and size of Ach and KpA language consultants' vowel spaces. Furthermore, this distance can also show the expansion of the vowel spaces from the vowels extracted from the two speaking contexts, which were citation words from WE and connected speech from INT.

3.5.2 Diphthong Measurements

The formants for diphthongs are assumed not to be steady because of the changing vowel quality from the onset to the offset of the vowel (Ladefoged, 2006). To capture this change in the vowel quality, this study applies the Rate of Change (ROC) (Gay, 1968) for the first formant by applying its formula (see Equation 3 in 2.5.3). This method was deemed suitable for this study as the data was collected from both elicited and spontaneous speech. As discussed in 2.5.3, Deterding (2000) also finds that ROC is more appropriate to be implemented for data from conversational speech.

As discussed in 2.5.3, ROC for a rising diphthong is expected to have a negative value because as the diphthong moves from a lower to a higher vowel where F1 decreases, such as the sound /ai/. Since Acehnese have both rising and centering diphthongs, this study also followed Lee and Lim (2000) who suggest the measurement of the F2 ROC for centering diphthongs because the F1 ROC is not likely to reflect the fronting/retraction dimension. Therefore, the F1 and F2 ROC values were both calculated for the rising and centering diphthongs in Acehnese.

An example of annotations for the diphthong is shown in Figure 3.8 for /uə/ in *buet* ‘work’. From this figure, Tiers 4 and 5 are for the onset and offset from both F1 and F2 and Tier 6 are for the vowel duration. Every diphthong was measured at the onset 20% and offset 80% for both the F1 and F2 to lessen the influence from adjoining sounds (Tsukada, 2008) as shown in Figure 3.8.

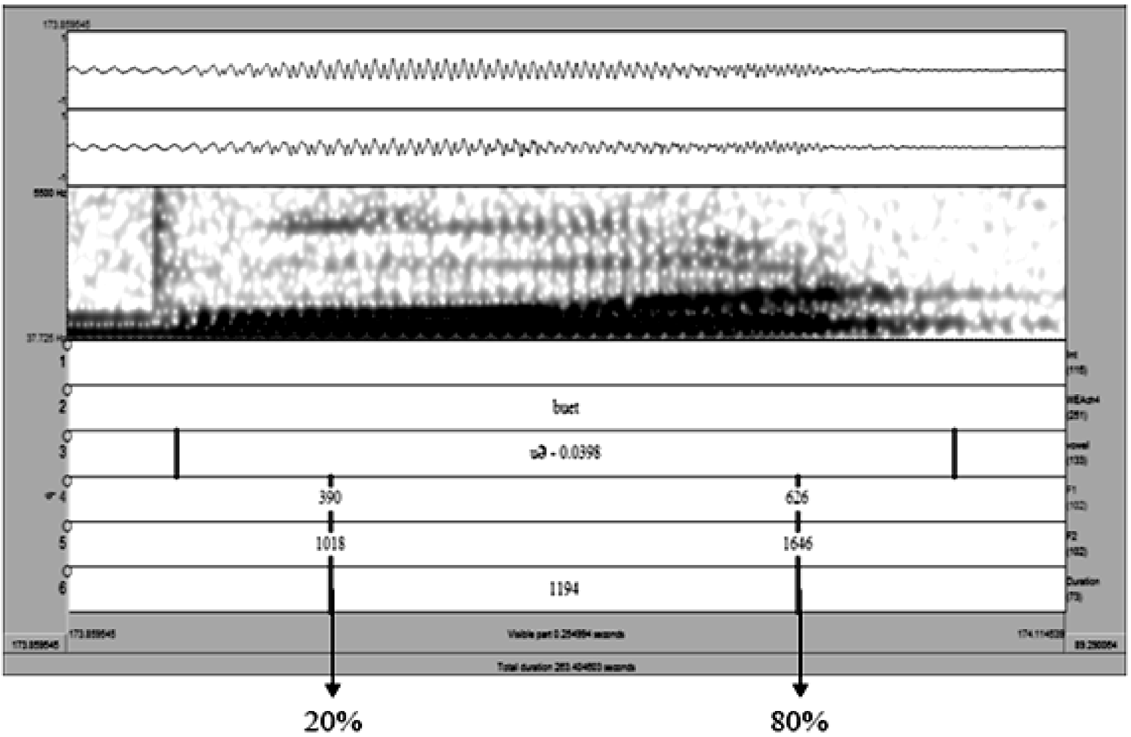


Figure 3.8: Sample measurement for a diphthong

Based on the limitation of ROC approach as mentioned by Gay (1968) (see 2.5.3), therefore, this study further plot trajectories of each diphthong produced by the language consultants to better see and compare the movements of these diphthongs. The average F1 and F2 values in Bark at the onset and offset of each diphthong were plotted in a vowel chart to obtain a visual representation of the diphthongs' trajectories (see Man, 2007; King, et al., 2009; Mayr & Davies, 2011).

3.6 Conclusion

This chapter presented the methodology used to examine the Acehnese monophthongs and diphthongs produced by Ach and KpA language consultants and to further explain the comparable data from SM and KD vowels that was used as a foundation to explain their possible influences on Acehnese vowels produced by KpA language consultants. To extract Acehnese vowels from Ach and KpA language consultants, two sets of data were used in the form of citation speech, or WE, and in the form of spontaneous speech, or INT. However, due to limitations of the study, SM and KD vowels were only extracted in the form of citation speech and this was deemed sufficient for comparable data.

It can be concluded that the most common approach to measure a monophthong is by extracting its formant values at its steady state of production, which is at the midpoint of the vowel duration. Additionally, the ROC values are ordinarily used to measure and analyze diphthongs. Trajectories of the diphthongs in the vowel space further help illustrate their movements.

The following chapter presents and discusses the findings of Acehnese monophthongs from WE and INT produced by Ach and KpA language consultants.

CHAPTER 4 : FINDINGS FROM MONOPHTHONGS

4.1 Introduction

This chapter presents the findings of monophthongs from word elicitation data (WE) and interview data (INT). Statistical analysis was also performed using independent samples t-tests to compare and determine whether the qualities of target vowels by Ach and KpA language consultants were produced similarly or differently. The values of Euclidean Distance for each vowel are presented in this chapter for further discussion in Chapter 7.

4.2 Monophthongs from WE

For the measurement of ten vowels from both Ach and KpA language consultants, a total of 576 elicitation tokens were selected. There were more tokens available, but these were selected as they were produced clearly by the speakers for measurements. Every language consultant from each group repeated 10 of the target words 3 times each and this resulted in 30 tokens for every vowel from every speaker. Therefore, 10 vowels from 10 language consultants with three repetitions for each vowel presented a total of 300 tokens for Ach language consultants, but only 276 for KpA language consultants. This was because from ten KpA language consultants, eight had said the word *cèt* 'paint', which was produced with [ɛ] by Ach language consultants, as *cat* with [a] similar to Malay. Only two pronounced it as *cèt* with [ɛ], which were by KpA7 and KpA8, respectively. Therefore, only 6 tokens of [ɛ] were extracted from this set of data and the other 24 tokens were removed. The list and measurements for the monophthongs in Hertz and Bark from WE are provided in Appendix J for Ach language consultants and Appendix K for KpA language consultants.

4.2.1 Ach Monophthongs from WE

The average duration, formant frequencies and standard deviations (SD) in parentheses for the F1 and F2 of each vowel produced by Ach language consultants are shown in Table 4.1. Euclidean distances (in Bark), or ED, from the center are also presented in the far right columns.

Table 4.1: F1 and F2 Average Values, and SD for Ach Monophthongs

Vowel	Target Word	Duration (sec)	Ave. F1 and SD (Hz)	Ave. F2 and SD (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)	ED (Bark)
i	*cit*	0.155 (0.05)	429 (27.73)	2653 (130.08)	4.11 (0.25)	14.87 (0.29)	3.30
e	*pét*	0.142 (0.04)	504 (49.31)	2518 (112.30)	4.77 (0.43)	14.55 (0.27)	2.80
ɛ	*cèt*	0.158 (0.04)	629 (52.82)	2386 (141.79)	5.82 (0.43)	14.22 (0.36)	2.46
ɯ	*peut*	0.177 (0.04)	470 (50.31)	1624 (154.32)	4.48 (0.44)	11.73 (0.63)	0.88
ʌ	*göt*	0.178 (0.18)	651 (50.46)	1745 (136.67)	6.00 (0.40)	12.21 (0.52)	1.11
a	*pat*	0.165 (0.06)	877 (51.40)	1831 (65.49)	7.69 (0.36)	12.53 (0.23)	2.45
u	*cut*	0.188 (0.16)	463 (37.95)	1367 (114.82)	4.41 (0.34)	10.58 (0.56)	1.55
o	*pôt*	0.158 (0.05)	531 (38.90)	1013 (85.61)	5.01 (0.33)	8.60 (0.55)	3.23
ɔ	*cop*	0.150 (0.04)	669 (43.49)	1412 (113.26)	6.14 (0.35)	10.79 (0.53)	1.29
ə*	*tet*	0.156 (0.03)	547 (27.20)	1825 (122.35)	5.14 (0.23)	12.51 (0.45)	0.73
Ave.		0.162 (0.01)					2.12

n. b. *central vowel

Table 4.1 shows the average duration for Ach monophthongs from WE, which is 0.162. The placement of vowels in the vowel space for Ach language consultants can be seen in Figure 4.1.

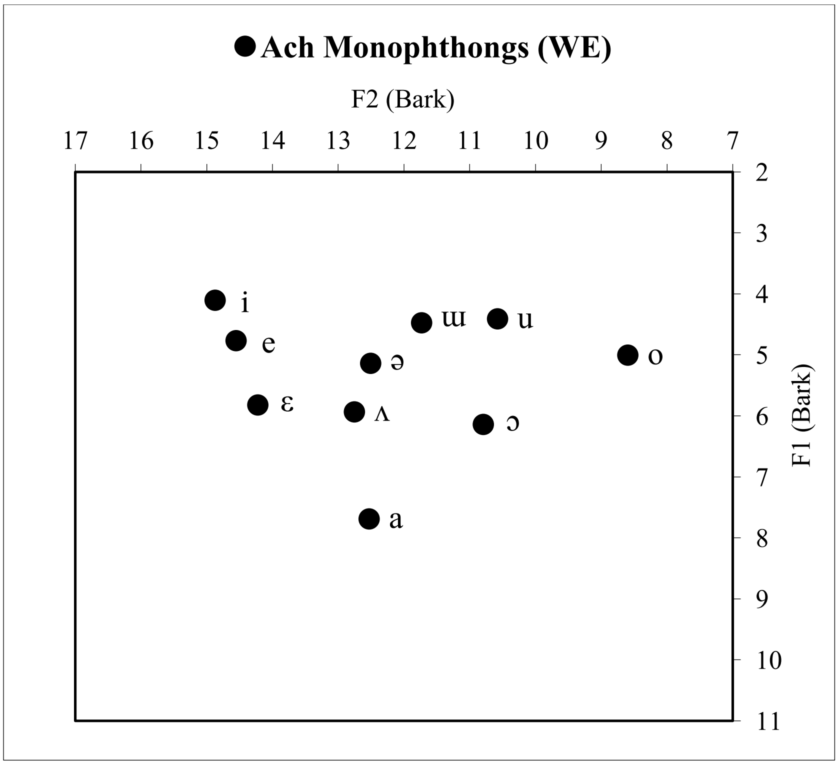


Figure 4.1: Plot of formant average values for Ach monophthongs from WE

The positions of [i], [e] and [ɛ] in Figure 4.1 are similar to the descriptions of these vowels in previous studies (e.g. Asyik, 1987; Durie, 1985; Sulaiman, et al., 1977), except that these three vowels are placed very close together, with [e] and [ɛ] located considerably higher than described by, for example, Asyik (1987) and Durie (1985). This could be due to the effect of target words used to elicit data and the variability in data.

4.2.1.1 Ach Front Vowels from WE

The scatter plot for [i], [e] and [ɛ] for Ach language consultants in Figure 4.2 shows that there is variability in the way that these vowels were produced by these speakers.

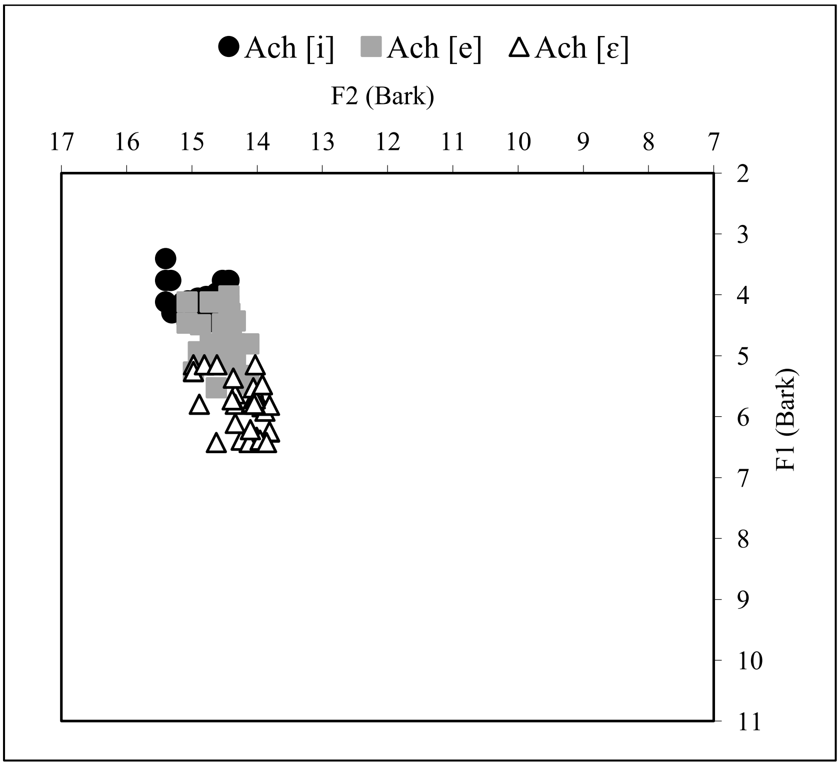


Figure 4.2: Scatter plot of Ach [i], [e] and [ɛ] from WE

Looking at the standard deviations (see Table 4.1), it is contended that this variability is not prominent but does cause overlaps between [i] and [e], and between [e] and [ɛ], suggesting that in some circumstances they were produced very similarly to each other. On the whole, the language consultants tended to maintain distinction between these three vowels as shown in Figure 4.3 and Figure 4.4, which represent the vowel charts for two of them. To further study the differences between [i] and [e] and between [e] and [ɛ], t-tests were conducted. Between [i] and [e], significant differences were found in the F1 and F2 average values (F1: $t(58)=7.26$, $p<.0001$; F2: $t(58)=4.31$, $p<.0001$), indicating that these vowels were produced differently. Between [e] and [ɛ], significant differences were also found in the F1 and F2 average values (F1: $t(58)=9.51$, $p<.0001$; F2: $t(58)=3.99$, $p<.0001$).

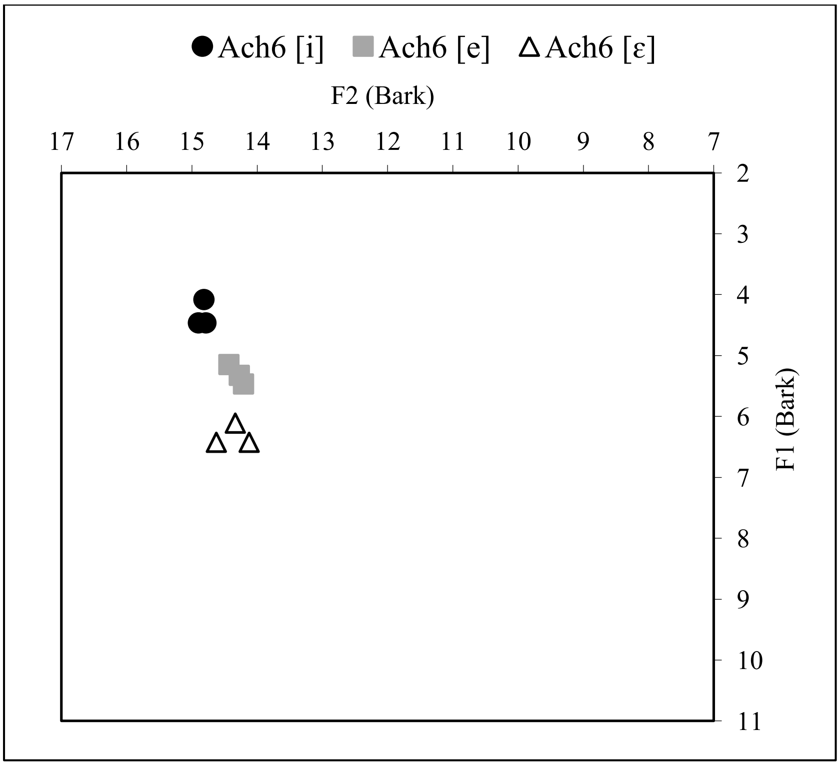


Figure 4.3: Scatter plot of Ach6 [i], [e] and [ɛ] from WE

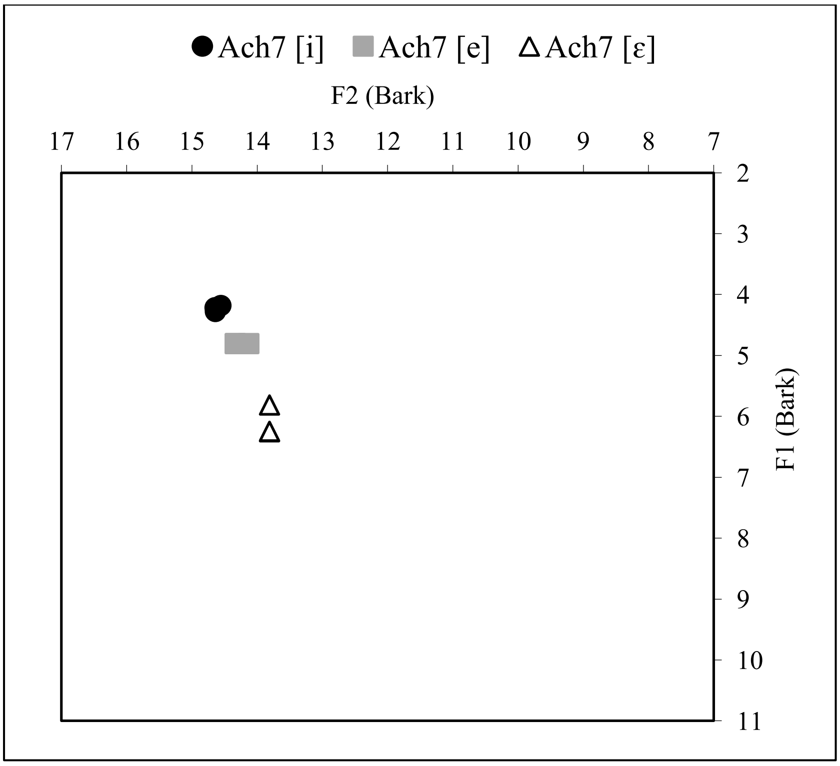


Figure 4.4: Scatter plot of Ach7 [i], [e] and [ɛ] from WE

4.2.1.2 Ach Central Vowels from WE

The distribution of [ɯ], [ə], [ʌ] and [a] by Ach language consultants is shown in Figure 4.5 where it can be seen that [ʌ] is more dispersed in the vowel space, indicating a higher degree of variability among these language consultants, with six of the tokens produced further front by two of them. As can be seen in Figure 4.5, the tokens of [ʌ] are more central, and this finding is similar to Durie (1985) and Asyik (1987) who find that /ʌ/ is located more central in the vowel chart.

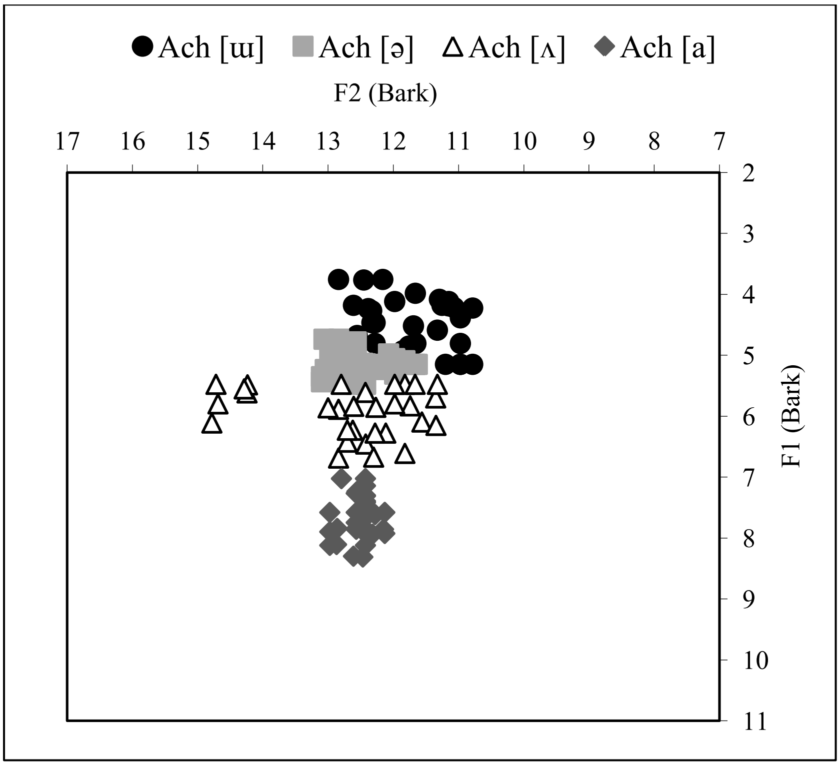


Figure 4.5: Scatter plot of Ach [ɯ], [ə], [ʌ] and [a] from WE

Based on Figure 4.5, there appears to be considerable overlaps between [ɯ] and [ə], and between [ə] and [ʌ]. T-tests between [ə] and [ɯ] showed no significant differences in the F1 and F2 average values (F1: t(58)=7.35, p<.0001; F2: t(58)=5.59, p<.0001), indicating a lack of overlap between the latter two vowels. No t-test could be conducted between [ə] and [ʌ] as the tokens for [ʌ] was *n*<30. Thus, their separate distribution as presented by each language consultant is represented by Ach10 in Figure 4.6 that shows these vowels were produced differently.

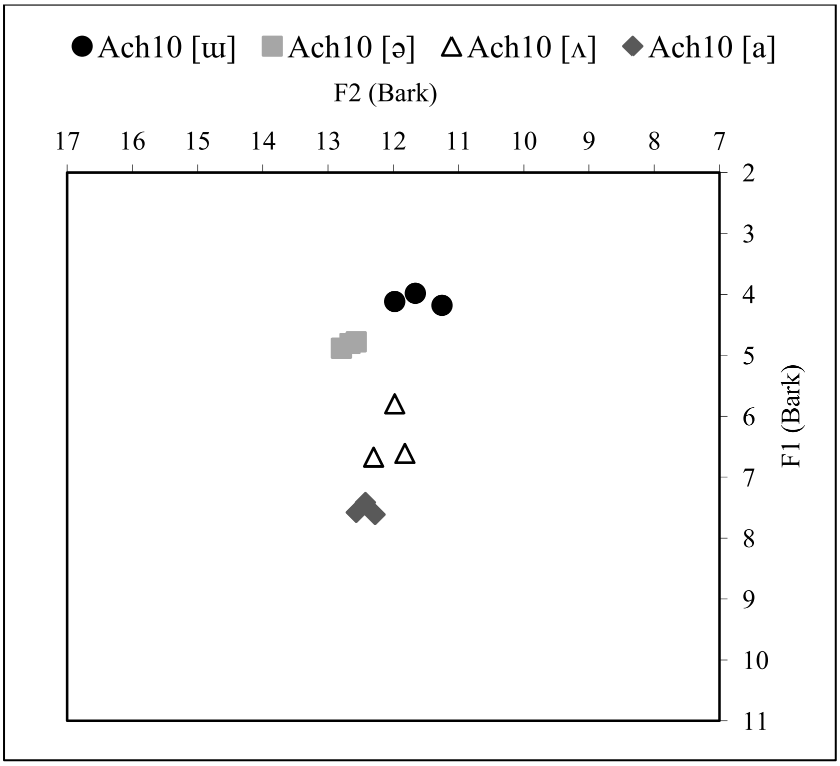


Figure 4.6: Scatter plot of Ach10 [ɯ], [ə], [ʌ] and [a] from WE

4.2.1.3 Ach Back Vowels from WE

Figure 4.7 shows the distribution of [u], [o] and [ɔ] by Ach language consultants in the vowel space where compared to Asyik (1987:17) and Durie (1985:16), Ach [u] and [ɔ] are consistently more fronted compared to [o] (based on the dispersion of each of these vowels). The more fronted positions of the latter two vowels can also be seen in Figure 4.7. However, the differences from Asyik (1987) and Durie (1985) may be due to differing speaking contexts (e.g. informal contexts) and speakers from different areas. Further, the vowel charts presented by their studies are largely based on auditory impressions (see 2.3 and 2.3.1.1). Durie (1985, p. 15) further points out for his monophthong chart that, “the spacing [in the chart] itself is not intended to be an indication of vowel quality”. It is also not clear at this point if lip rounding may have had an effect on the F1 and F2 average values given the lack of comparable acoustic data as Durie's (1985, p. 18) formant plot is based on only one speaker from another area, Pidie (see 2.3, Figure 2.2).

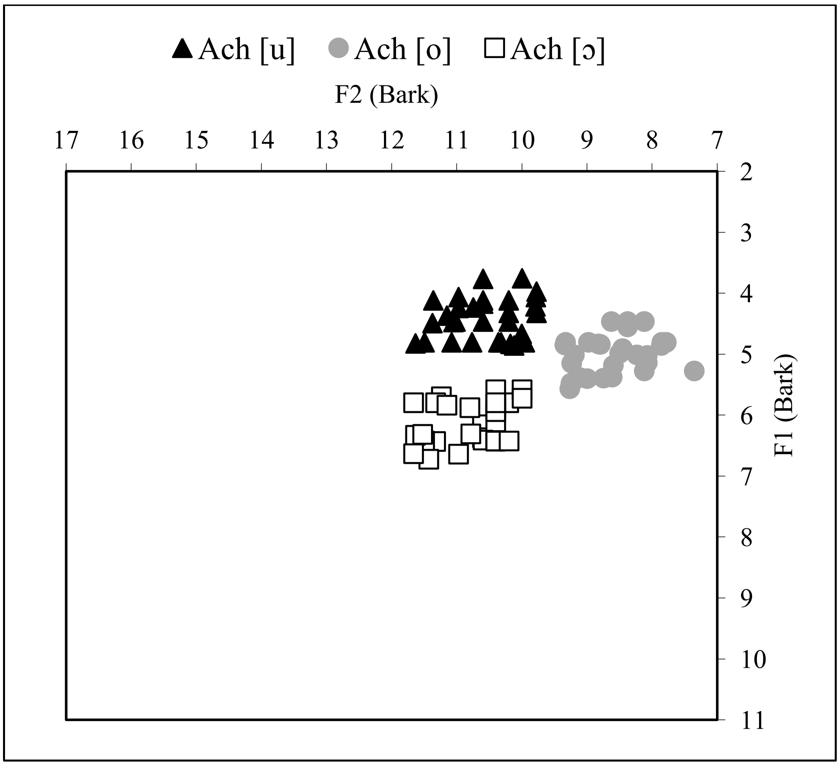


Figure 4.7: Scatter plot of Ach [u], [o] and [ɔ] from WE

4.2.2 KpA Monophthongs from WE

The average duration, formant frequencies and SD (in parentheses) for the F1 and F2 of each vowel produced by KpA language consultants are shown in Table 4.2. ED (in Bark) from the center is also presented in far right columns.

Table 4.2: F1 and F2 Average Values, and SD for KpA Monophthongs

Vowel	Target Word	Duration (sec)	Ave. F1 and SD (Hz)	Ave. F2 and SD (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)	ED
i	*cit*	0.142 (0.03)	424 (21.30)	2775 (126.67)	4.07 (0.19)	15.14 (0.26)	3.57
e	*pét*	1.64 (0.03)	486 (28.05)	2666 (129.06)	4.62 (0.25)	14.90 (0.30)	3.18
ɛ	*cèt*	0.111 (0.04)	580 (41.24)	2214 (174.40)	5.42 (0.34)	13.75 (0.45)	1.94
ɯ	*peut*	0.179 (0.04)	476 (39.20)	1920 (131.96)	4.52 (0.34)	12.85 (0.45)	1.33
ʌ	*göt**	0.192 (0.06)	583 (36.82)	2532 (136.54)	5.44 (0.31)	14.59 (0.34)	2.78
a	*pat*	0.176 (0.03)	928 (83.63)	1995 (57.67)	8.04 (0.55)	13.09 (0.19)	2.97
u	*cut*	0.161 (0.03)	455 (32.79)	1499 (162.44)	4.35 (0.29)	11.19 (0.71)	1.18
o	*pôt*	0.173 (0.04)	499 (27.77)	1124 (80.62)	4.73 (0.24)	9.27 (0.47)	2.62
ɔ	*cop*	0.172 (0.04)	648 (37.75)	1380 (84.80)	5.98 (0.30)	10.64 (0.42)	1.33
ə**	*tet****	0.174 (0.06)	525 (21.34)	1489 (138.00)	4.95 (0.18)	11.15 (0.61)	0.77
Ave.		0.164 (0.02)					2.32

n.b. *most of /ʌ/ in *göt* is realized closer to [ɛ] (27 tokens)
**central vowel
***/ə/ in *tet* is realized closer to [ɵ].

To better view the placement of vowels in the vowel space, the plot of formant average values of Acehnese vowels by KpA language consultants are presented in Figure 4.8.

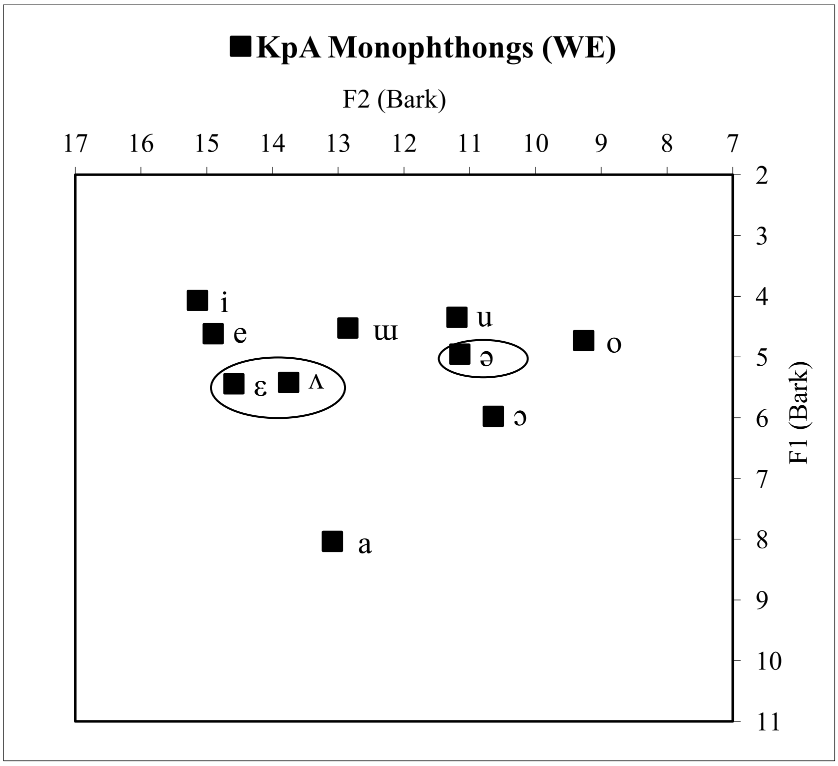


Figure 4.8: Plot of formant average values for KpA monophthongs from WE
n.b. /ʌ/ in *göt* is realized closer to [ɛ], and /ə/ in *tet* is realized closer to [ɵ].

Figure 4.8 shows Acehnese vowels by KpA language consultants generally has fewer monophthongs with only nine realizations compared to those by Ach language consultants. WE further imply that KpA language consultants have lost the realization of /ʌ/ in their monophthongs, where the extraction of the vowel /ʌ/ from *göt* was produced as [ɛ]. The central vowel /ə/ from *tet* is also seen to be produced more back, closer to [ɵ].

4.2.2.1 KpA Front Vowels from WE

Similar to Ach language consultants, Figure 4.9 shows the scatter plot for [i], [e] and [ɛ] by KpA language consultants and it also illustrates variability in the way that these vowels were produced. As mentioned earlier in 4.2, only 6 tokens were extracted for [ɛ] and 24 tokens were removed due to different pronunciation.

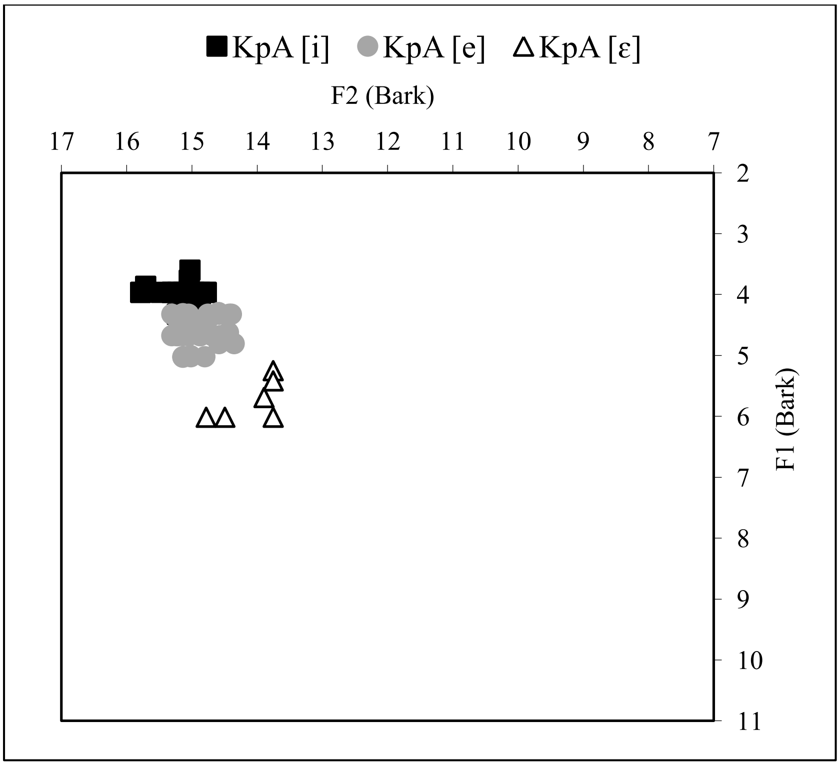


Figure 4.9: Scatter plot of KpA [i], [e] and [ɛ] from WE

Based on the standard deviations (see Table 4.2), this variability is asserted not to be high but overlap between [i] and [e] is clearly seen in Figure 4.9, which implies that they were produced similarly in some instances. Figure 4.10 and Figure 4.11 show scatter plots of the vowel produced by two language consultants, KpA7 and KpA8. T-tests between [i] and [e] showed that there was a significant difference in the F1 average values ($t(58)=9.62$, $p<.0001$), but no significant difference was found in the F2 average values ($t(58)=3.3$, $p=0.001$). This indicates that these two vowels were differentiated by F1 in production; where [e] is lower than [i] as seen in Figure 4.10 and Figure 4.11. No t-test could be conducted between [e] and [ɛ] as the tokens for [ɛ] was $n<30$. Thus, their separate distribution as presented in Figure 4.9 shows that these vowels were produced differently.

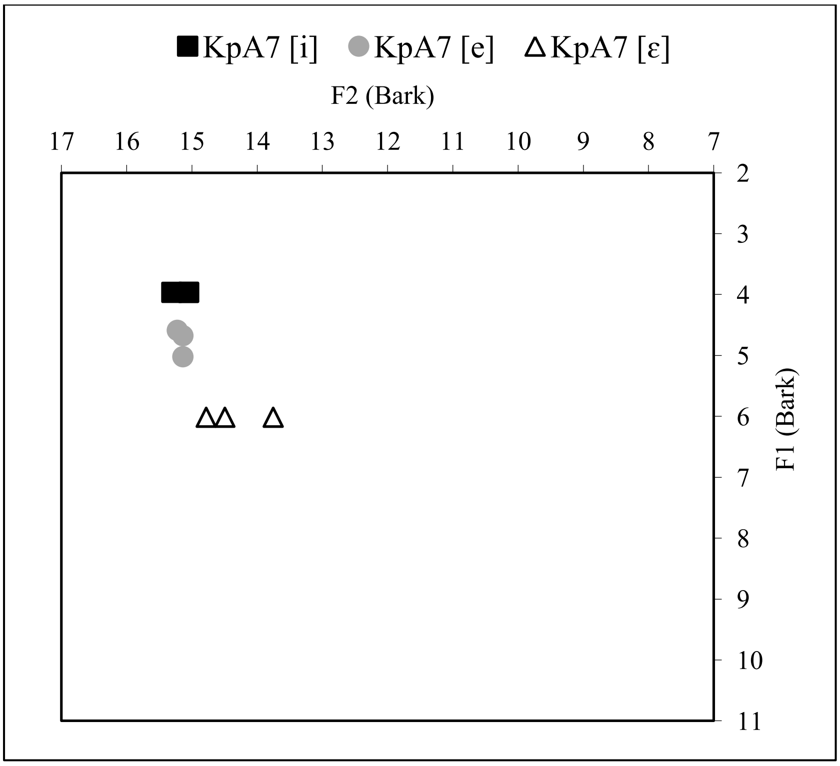


Figure 4.10: Scatter plot of KpA7 [i], [e] and [ɛ] from WE

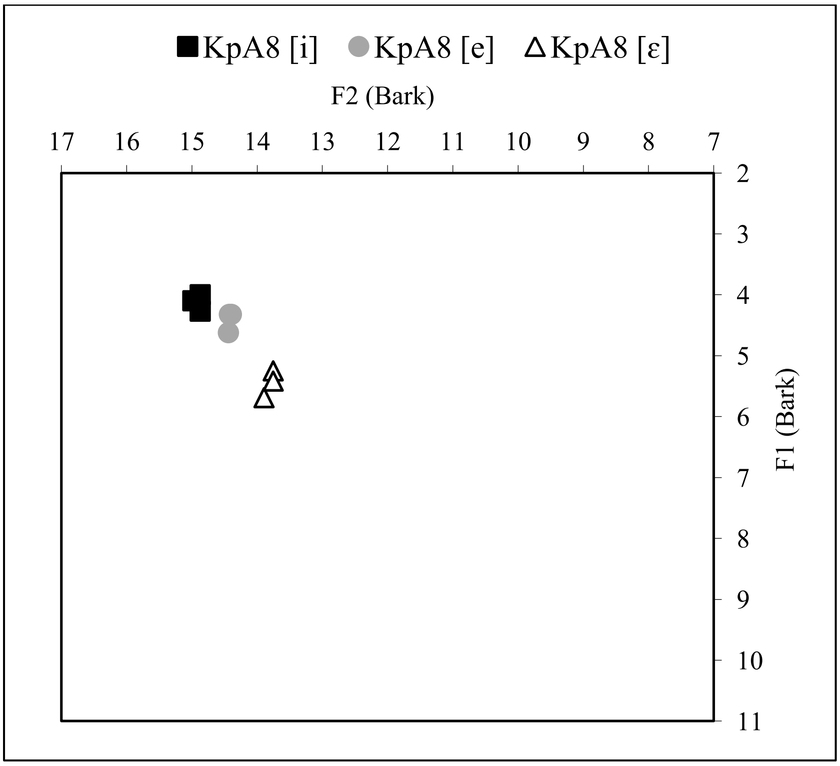


Figure 4.11: Scatter plot of KpA8 [i], [e] and [ɛ] from WE

4.2.2.2 KpA Central Vowels from WE

Figure 4.12 shows the distribution of [ɯ], [ə], [ʌ] and [a] by KpA language consultants. Here, it is seen that the production of *göt* is distant from /ʌ/ in the vowel space, with most of the language consultants producing it closer to [ɛ] (27 tokens) and one language consultant as [ɔ] (three tokens). The F2 from the production of *göt* also reflected the higher degree of variability as it had the highest standard deviation (see Table 4.2). Furthermore, the production of what should be /ə/ from *tet* is seen to be produced further back in the vowel space rather than centrally by these language consultants, suggesting it was produced closer to [ɵ].

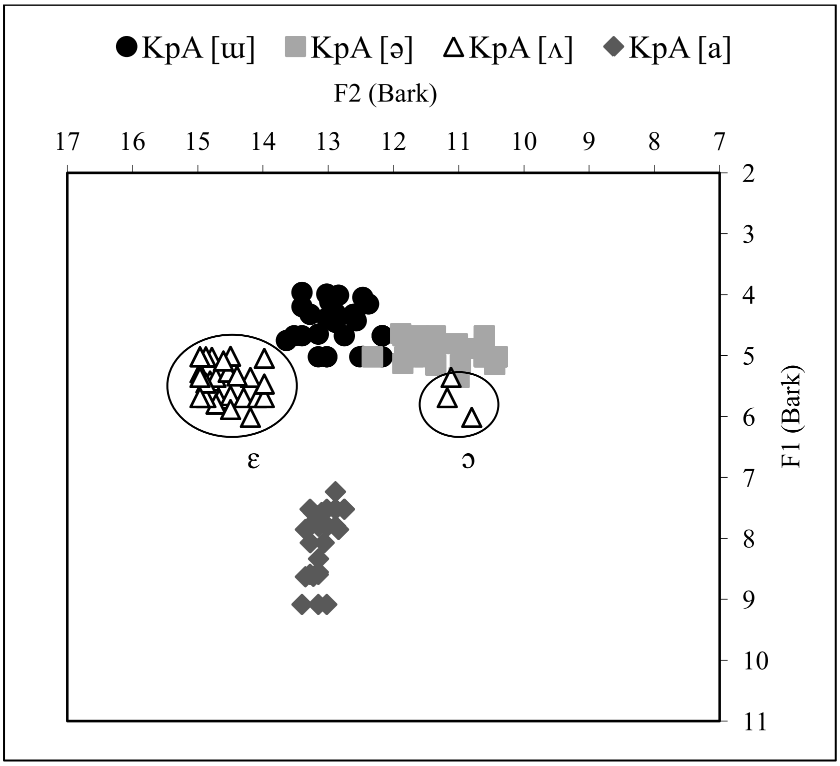


Figure 4.12: Scatter plot of KpA [ɯ], [ə], [ʌ] and [a] from WE

4.2.2.3 KpA Back Vowels from WE

Figure 4.13 shows the distribution of [u], [o] and [ɔ] by KpA language consultants in the vowel space and their distribution is similar to these vowels by Ach language consultants in Figure 4.7, where [u] and [ɔ] are further fronted in the vowel space compared to [o].

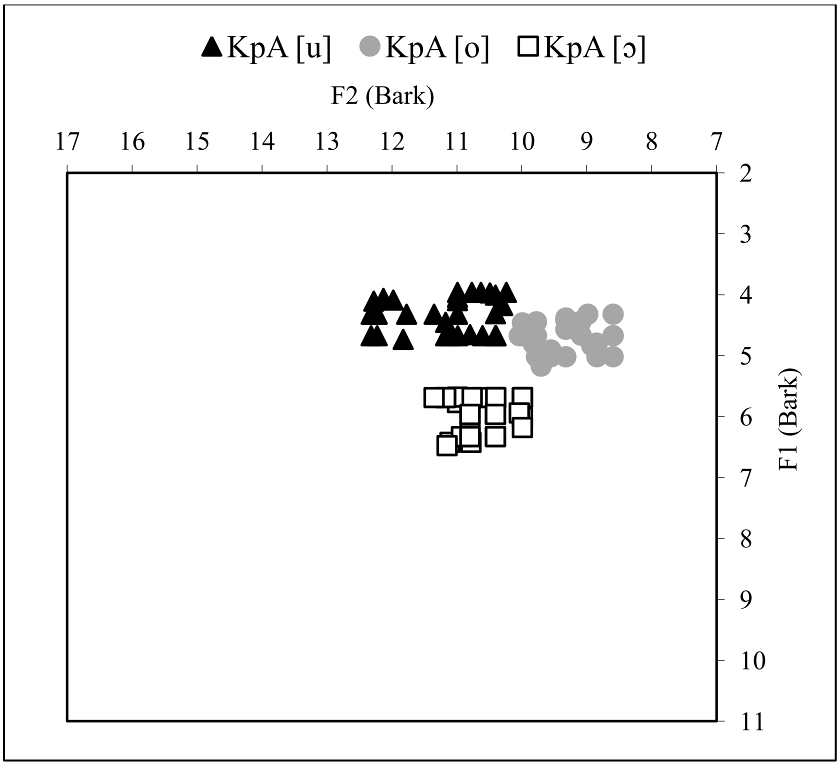


Figure 4.13: Scatter plot of KpA [u], [o] and [ɔ] from WE

4.2.3 Ach vs. KpA Monophthongs from WE

The comparison of each vowel between Ach and KpA language consultants is further discussed in the following subsections. The F1 and F2 values in Hertz and Bark for each vowel are provided in Appendix J for Ach monophthongs measurements from WE and Appendix K for KpA monophthongs measurements from WE.

4.2.3.1 The production of /i/ in *cit*

For /i/ in *cit*, the average value of F1 for Ach [i] is 429 Hz (see Appendix J.1) and for KpA [i] is 424 Hz (see Appendix K.1), t-test between them showed no significant difference (t(58)=0.66, p=0.256). The average value of F2 for Ach [i] is 2653 Hz, while KpA [i] is at 2775 Hz, and again a t-test between them also showed that there was no significant difference (t(58)=3.67, p=0.000). The distribution of Ach [i] and KpA [i] are shown in Figure 4.14 that obviously shows an overlap between the vowels produced by these language consultants from two locations, meaning that they are produced similarly.

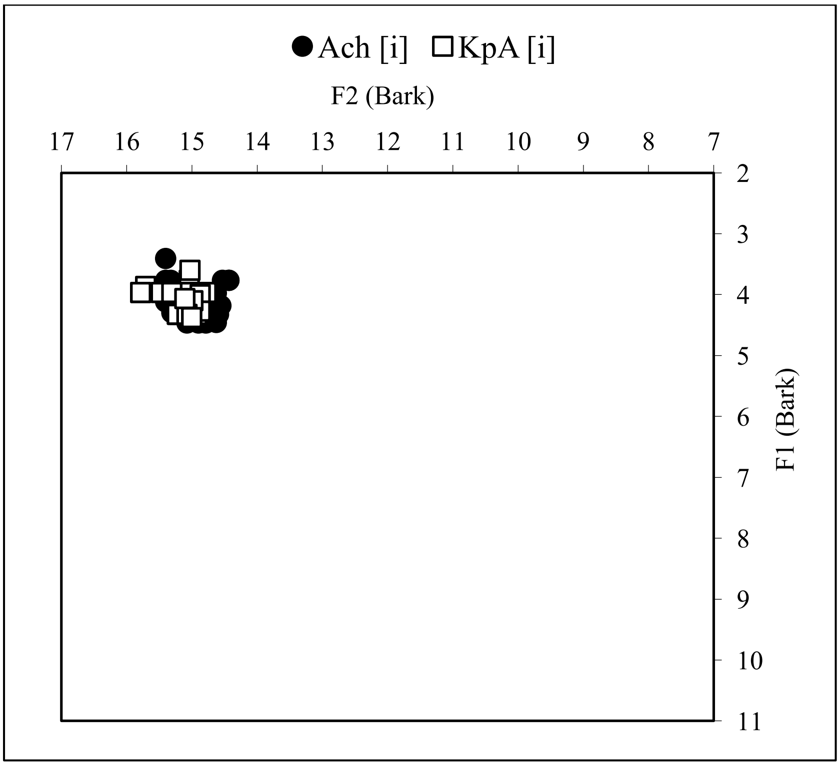


Figure 4.14: Distribution of Ach [i] and KpA [i] from *cit*

4.2.3.2 The production of /e/ in *pét*

For /e/ in *pét*, the average value of F1 for Ach [e] is 504 Hz (see Appendix J.2) and KpA [e] is 486 Hz (see Appendix K.2). No significant difference was found in the F1 average values ($t(58)=1.67$, $p=0.050$). The average value of F2 for Ach [e] is 2518 Hz and KpA [e] is 2666 Hz, and a t-test between them showed a significant difference ($t(58)=4.74$, $p<.0001$). Figure 4.15 shows their scatter plot that suggests KpA [e] to be produced a little more fronted compared to Ach [e]. However, there does not appear to be much difference in the way this would be in its production in both locations, therefore, they were produced similarly.

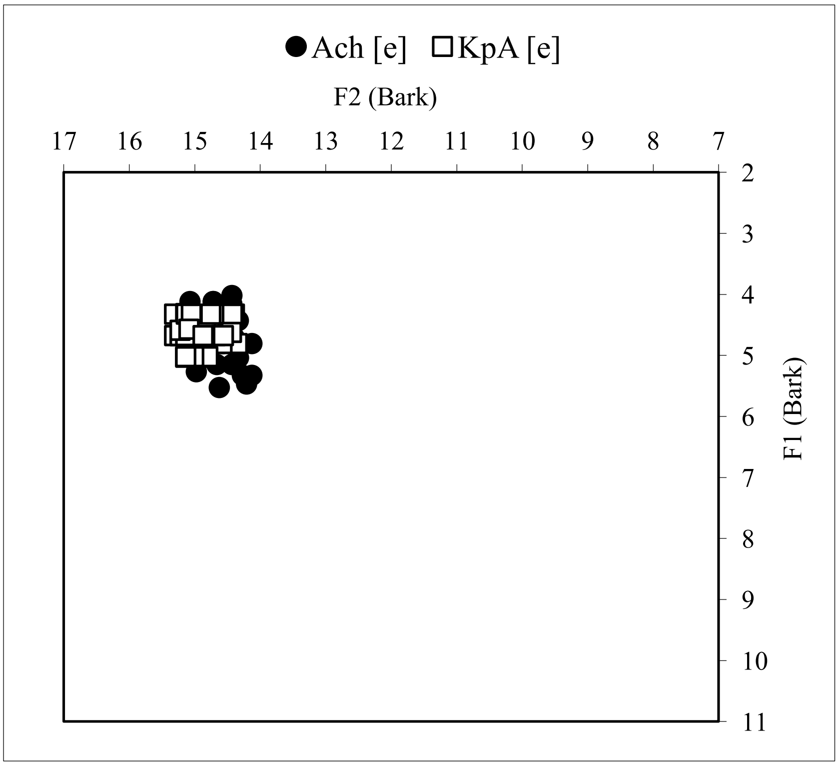


Figure 4.15: Distribution of Ach [e] and KpA [e] from *pét*

4.2.3.3 The production of /ɛ/ in *cèt*

As mentioned earlier in 4.2, only 6 tokens of KpA [ɛ] were selected for this set of data from *cèt*, whilst the other 24 tokens in *cat* with [a] were removed from data. No t-test could be conducted between Ach [ɛ] and KpA [ɛ] as the sample tokens from KpA language consultants for this vowel was *n*<30 (see 3.5). The average value of F1 for Ach [ɛ] is 629 Hz (see Appendix J.3) and KpA [ɛ] is 619 Hz (see Appendix K.3). The average value of F2 for Ach [ɛ] is 2386 Hz and KpA [ɛ] is 2336 Hz. The values indicated that Ach [ɛ] was slightly more front and higher compared to KpA [ɛ]. Thus, based on the scatter plot in Figure 4.16, tokens of Ach [ɛ] and KpA [ɛ] overlap considerately and this suggests that they were produced similarly by both groups of language consultants.

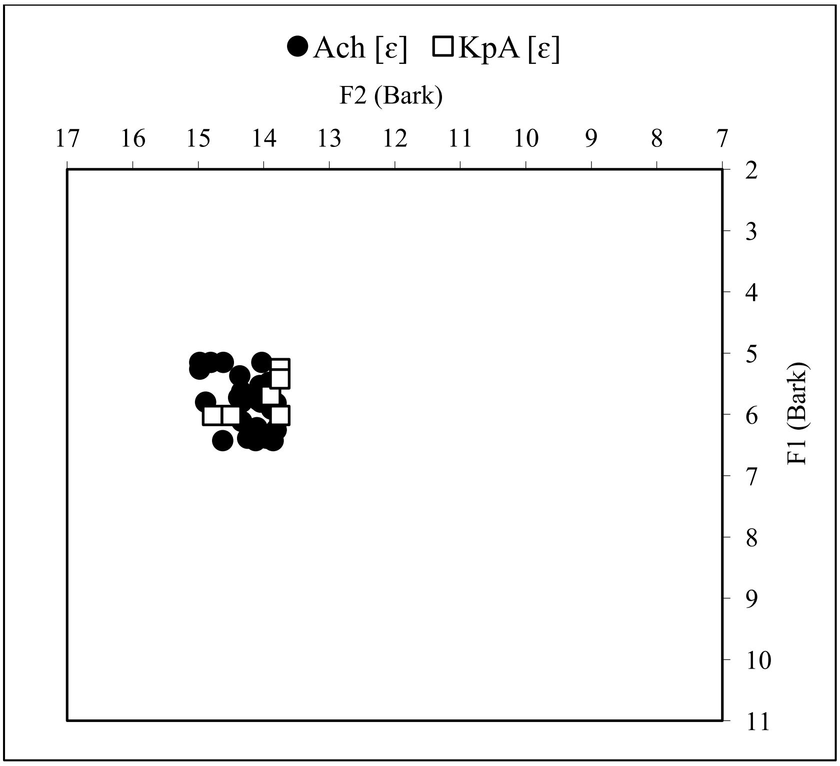


Figure 4.16: Distribution of Ach [ɛ] and KpA [ɛ] from *cèt*

4.2.3.4 The production of /ɯ/ in *peut*

For /ɯ/ in *peut*, the average value of F1 for Ach [ɯ] is 470 Hz (see Appendix J.4), while KpA [ɯ] is 476 Hz (see Appendix K.4). No significance difference was found in the F1 average values (t(58)=0.47, p=0.320). The average value of F2 for Ach [ɯ] is 1624 Hz, while KpA [ɯ] is 1924 Hz. This suggests that KpA [ɯ] was produced more fronted than Ach [ɯ] and a t-test showed a significant difference in the F2 average values (t(58)=8.1, p<.0001). Figure 4.17 shows the scatter plot of Ach [ɯ] and KpA [ɯ] and it demonstrates that KpA [ɯ] is more fronted than Ach [ɯ].

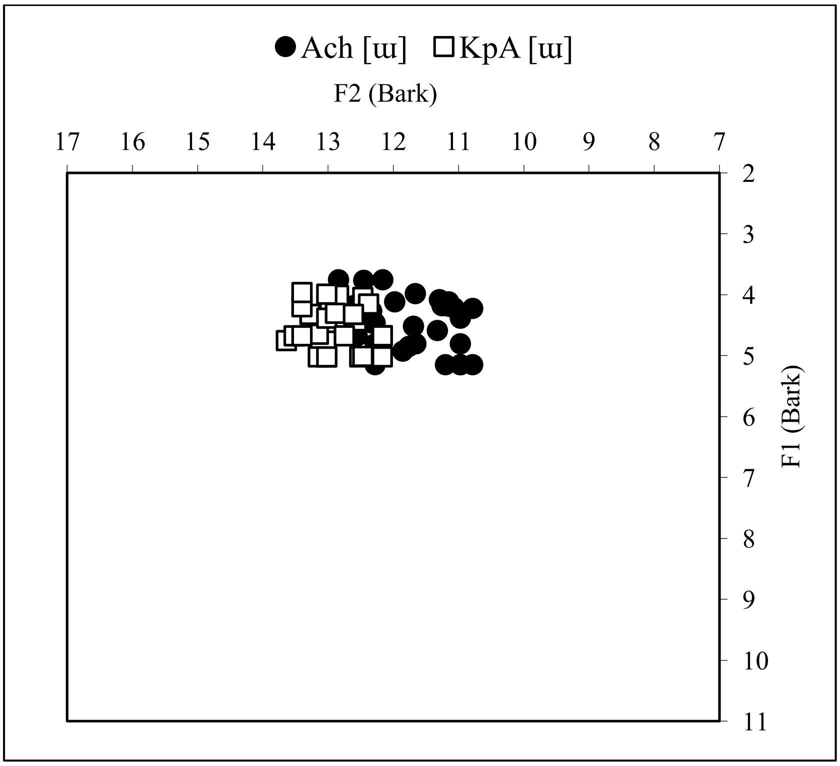


Figure 4.17: Distribution of Ach [ɯ] and KpA [ɯ] from *peut*

4.2.3.5 The production of /ə/ in *tet*

For /ə/ in *tet*, no significant difference was found in the F1 average values for Ach [ə] (547 Hz) (see Appendix J.5) and KpA [ə] (525 Hz) (see Appendix K.5): ($t(58)=3.47$, $p=0.001$). However, a significant difference was found in the F2 average values of Ach [ə] (1825 Hz) and KpA [ə] (1489 Hz): $t(58)=9.97$, $p<.0001$. This suggests that KpA [ə] was produced further back than Ach [ə] and this can be seen in Figure 4.18. Auditorily, this vowel in *tet* was produced as [ɵ] by KpA language consultants and lip rounding was noticed during the recording sessions with this group of speakers.

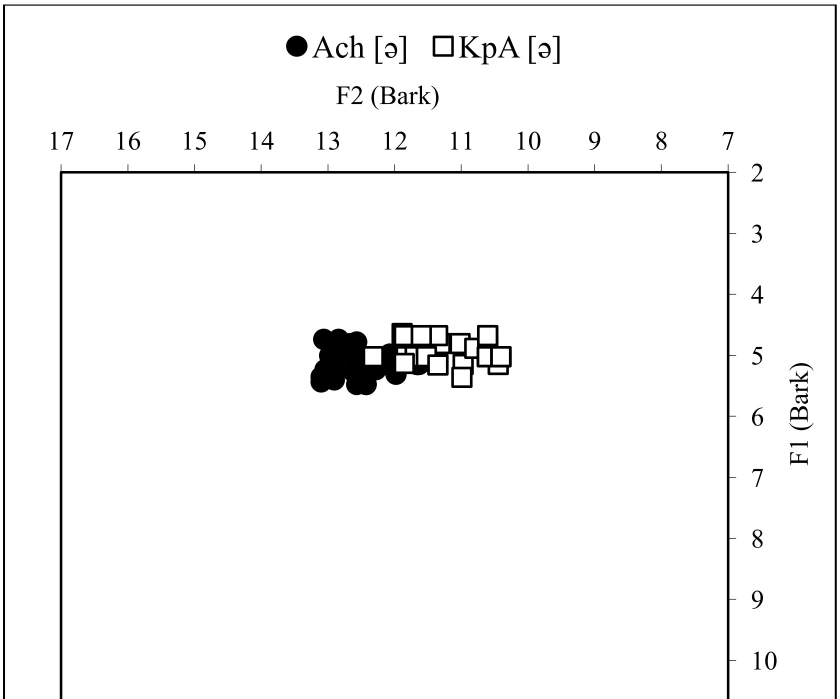


Figure 4.18: Distribution of Ach [ə] and KpA [ə] from *tet*
n.b. /ə/ in *tet* is realized closer to [ɵ] by KpA language consultants.

4.2.3.6 The production of /ʌ/ in *göt*

As discussed earlier, the vowel /ʌ/ from *göt*, did not appear in KpA language consultants' speech from this set of data. As a result, a comparison could not be conducted on its qualities between its production from Ach and KpA language consultants. Across speakers, a fair amount of vowel variability was also found. Ach language consultants produced it as [ʌ] (27 tokens), and one language consultant produced it further front, closer to [ɛ] (three tokens). Eight KpA language consultants produced the vowel further front, closer to [ɛ] (24 tokens) and two language consultants produced it further back, closer to [ɔ] (six tokens). Therefore, to study the F1 and F2 average values of Ach [ʌ], those which were produced with [ɛ] (3 tokens) were removed, resulting in the average values for [ʌ] (27 tokens) with F1 at 651 Hz and F2 at 1745 Hz. The distribution of Ach [ʌ] and KpA [ʌ] are shown in Figure 4.19. The plot visibly demonstrates that the word *göt* was produced differently by both groups of language consultants, where Ach language consultants predominantly produced the vowel in *göt* as [ʌ], thus, KpA language consultants produced the vowel in *göt* as [ɛ] and [ɔ].

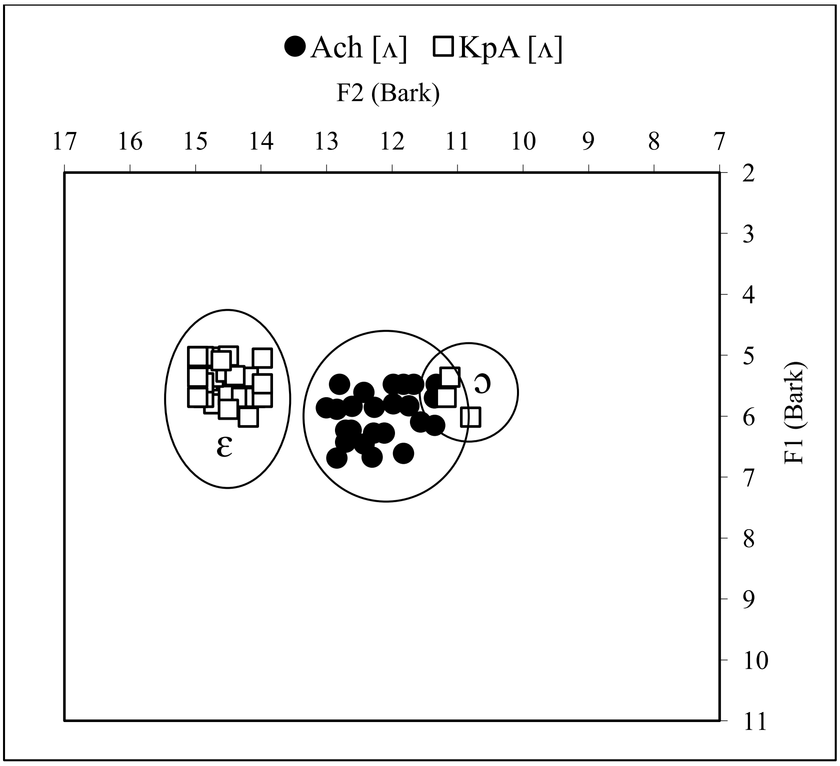


Figure 4.19: Distributions of Ach [ʌ] and KpA [ʌ] from *göt*
n.b. /ʌ/ in *göt* is realized as [ɛ] and [ɔ] by KpA language consultants.

4.2.3.7 The production of /a/ in *pat*

For /a/ in *pat*, no significant difference was found in the F1 average values of Ach [a] (877 Hz) (see Appendix J.7) and KpA [a] (928 Hz) (see Appendix K.7): (t(58)=2.82, p=0.003). However, a significant difference was found in the F2 average values for Ach [a] (1831 Hz) and KpA [a] (1995 Hz): t(58)=10.28, p<.0001), which suggests that KpA [a] was produced more fronted compared to Ach [a] and this is displayed in the scatter plot in Figure 4.20.

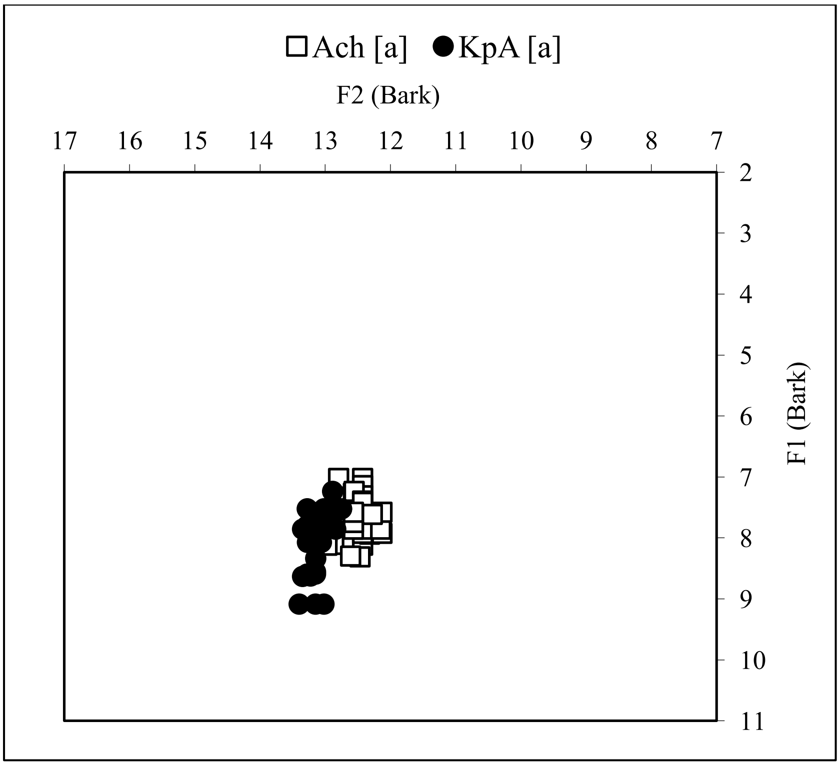


Figure 4.20: Distribution of Ach [a] and KpA [a] from *pat*

4.2.3.8 The production of /u/ in *cut*

For /u/ in *cut*, The average value of F1 for Ach [u] is 463 Hz (see Appendix J.8), while KpA [u] is 455 Hz (see Appendix K.8). A t-test showed no significant difference in the F1 average values (t(58)=0.8, p=0.214). The average value of F2 for Ach [u] is 1367 Hz, while KpA [u] is 1499 Hz. Despite the tokens of KpA [u] seeming to be more fronted than Ach [u] as shown in Figure 4.21, a t-test between them showed no significant difference (t(58)=3.62, p=0.000). This suggests that the language consultants in both locations produced the same vowel and this is illustrated by the scatter plot of Ach [u] and KpA [u] in Figure 4.21, which shows overlapping distribution.

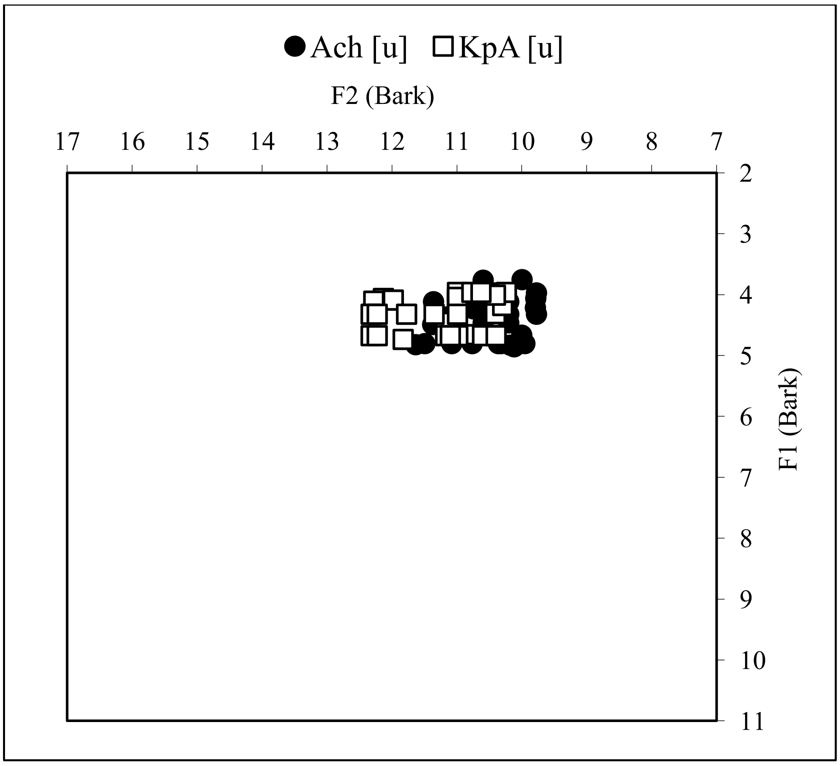


Figure 4.21: Distribution of Ach [u] and KpA [u] from *cut*

4.2.3.9 The production of /o/ in *pôt*

For /o/ in *pôt*, the average value of F1 for Ach [o] is 531 Hz (see Appendix J.9) and KpA [o] is 499 Hz (see Appendix K.9). A t-test between them indicated that there was no significant difference in the F1 average values (t(58)=3.66, p=0.000). However, a t-test showed that there was a significant difference in the F2 average values (t(58)=5.14, p<.0001) between Ach [o] F2 average value at 1013 Hz and KpA [o] F2 average value at 1124 Hz. Figure 4.22 further illustrates that KpA [o] was produced more fronted than Ach [o].

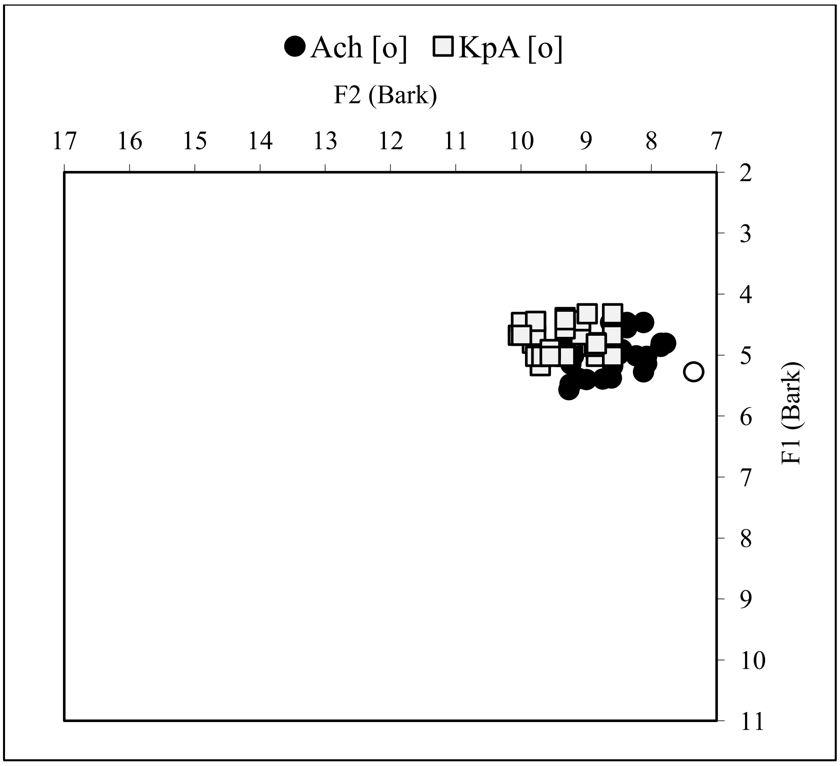


Figure 4.22: Distribution of Ach [o] and KpA [o] from *pôt*

4.2.3.10 The production of /ɔ/ in *cop*

For /ɔ/ in *cop*, the average value of F1 for Ach [ɔ] is 669 Hz (see Appendix J.10) while KpA [ɔ] is 648 Hz (see Appendix K.10). The average value of F2 for Ach [ɔ] is 1412 Hz while KpA [ɔ] is 1380. T-tests between [ɔ] produced by these two groups of language consultants also revealed that there were no significant differences in the F1 and F2 average values (F1: $t(58)=1.96$, $p=0.027$; F2: $t(58)=1.23$, $p=0.223$). Figure 4.23 shows the overlapping tendencies between the vowels that verifies their similar production.

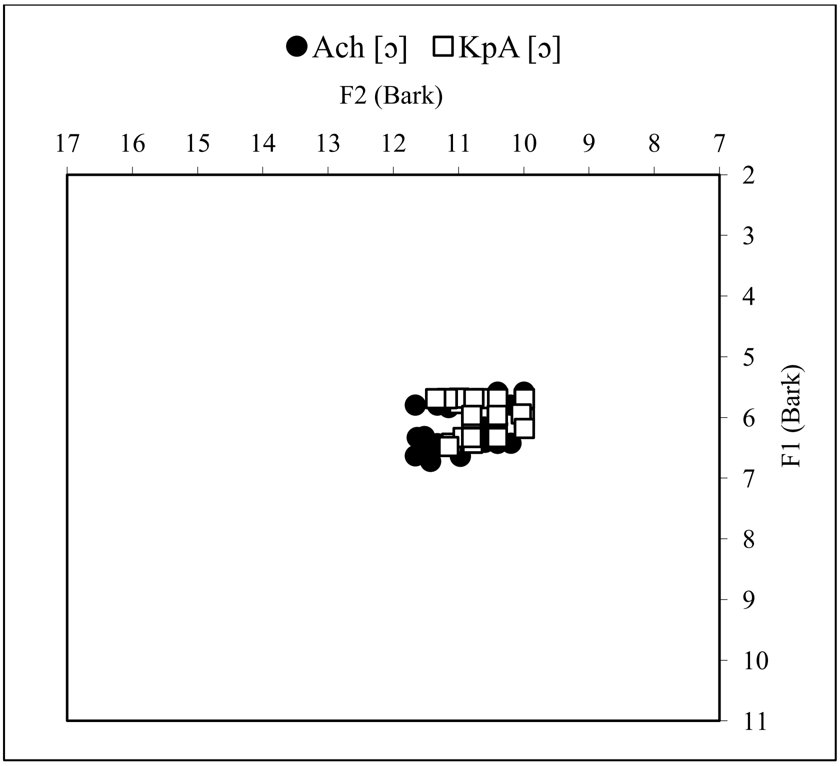


Figure 4.23: Distribution of Ach [ɔ] and KpA [ɔ] from *cop*

4.3 Monophthongs from INT

For the measurement of ten vowels from both Ach and KpA language consultants from INT, a total of 5649 tokens were selected. Table 4.3 presents the total number of tokens selected for each vowel from these two groups of language consultants.

Table 4.3: Ach Monophthongs from INT

Ach Monophthongs	Number of selected tokens
i	468
e	410
ɛ	121
ɯ	261
ə	8*
ʌ	96
a	1164
u	132
o	210
ɔ	332
Total	**3202**

n.b. Only 8 tokens were selected for /ə/, therefore no t-test could be conducted as *n*<30.

Table 4.4: KpA Monophthongs from INT

KpA Monophthongs	Number of selected tokens
i	296
e	181
ɛ	361
ɯ	184
ə	7*
a	827
ɑ	90
u	71
o	206
ɔ	210
Total	**2433**

n.b. Only 7 tokens were selected for /ə/, therefore no t-test could be conducted as *n*<30. No samples at all were found for /ʌ/; therefore it was excluded from the table.

From Table 4.4, an additional sound by KpA language consultants, which is [ɑ], was found and this was not found in WE. This occurrence demonstrates the importance of extracting vowels from both citation words and connected speech. The citation words provides basic information on the Acehnese vowels that are changing and or maintained by KpA language consultants, while the connected speech data further provides information on other possible vowels produced by these language consultants. The production of the monophthongs from this set of data is further discussed in the following subsections.

4.3.1 Ach Monophthongs from INT

The duration, average formant frequencies and SD (in parentheses) for the F1 and F2 of each vowel produced by Ach language consultants are shown in Table 4.5. ED (in Bark) from the center is also presented in the right columns. Thus, from Ach [ɯ], there appeared to be two outliers found from 263 measurements from its general pattern, where the first formants were numerically distant from the rest of the samples in which it occurred. Therefore, they were removed from data, resulting in 261 tokens remaining.

Table 4.5: F1 and F2 Average Values, and SD for Ach Monophthongs

Vowel	Duration (sec)	Ave. F1 and SD (Hz)	Ave. F2 and SD (Hz)	Ave. F1 and SD (Bark)	Ave. F2 and SD (Bark)	ED
i	0.094 (0.05)	489 (42.83)	2663 (167.68)	4.63 (0.38)	14.88 (0.38)	3.15
e	0.102 (0.05)	555 (26.40)	2516 (172.04)	5.20 (0.22)	14.55 (0.42)	2.74
ɛ	0.104 (0.05)	658 (51.51)	2335 (125.97)	6.06 (0.41)	14.09 (0.33)	2.39
ɯ	0.094 (0.05)	550 (41.02)	1820 (153.57)	5.16 (0.35)	12.49 (0.56)	0.70
ʌ	0.128 (0.06)	710 (48.78)	1806 (158.96)	6.46 (0.38)	12.44 (0.71)	1.28
a	0.104 (0.05)	880 (87.81)	1854 (123.20)	7.71 (0.59)	12.61 (0.45)	2.49
u	0.097 (0.05)	486 (40.30)	1181 (134.09)	4.61 (0.35)	9.60 (0.74)	2.33
o	0.106 (0.05)	550 (26.76)	1186 (109.32)	5.17 (0.23)	9.63 (0.61)	2.19
ɔ	0.109 (0.06)	659 (48.57)	1289 (139.49)	6.07 (0.38)	10.18 (0.72)	1.78
ə*	0.082 (0.06)	623 (18.52)	1874 (154.18)	5.77 (0.15)	12.68 (0.54)	0.97
Ave.	0.102 (0.01)					2.12

n. b. *central vowel

To illustrate the placement of vowels in the vowel space from INT, the plot for formant average values of Acehnese vowels by Ach language consultants are presented in Figure 4.24.

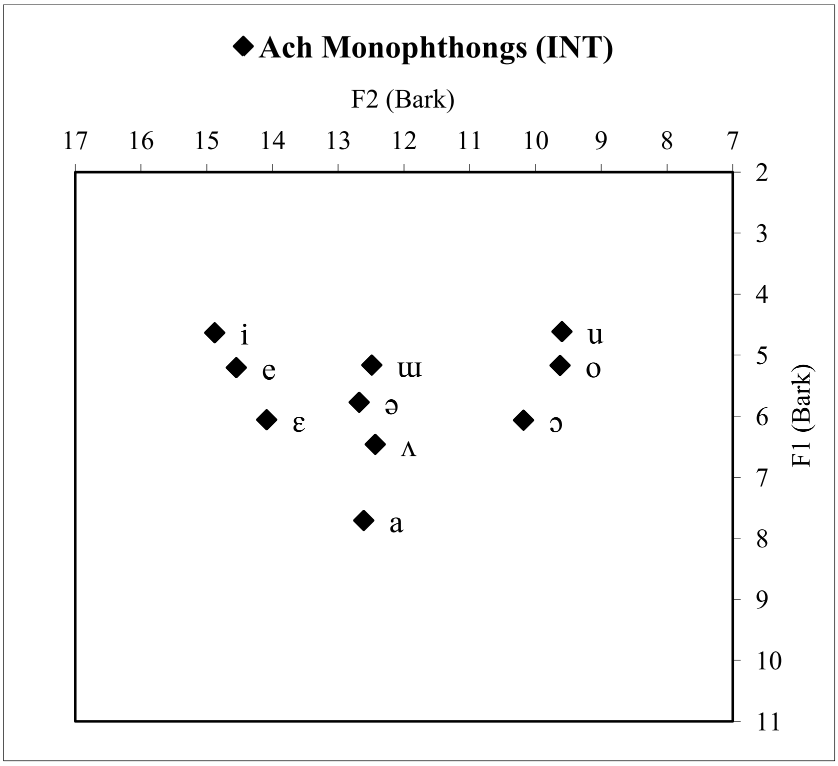


Figure 4.24: Plot of formant average values for Ach monophthongs from INT

Compared to Figure 4.1 in 4.2.1, there is a clearer distinction of the center and back vowels, where [ɯ] is seen to be positioned more in the center of the vowel space, and [u] and [ɔ] is seen to be produced more back in the vowel space. A discussion on these distinctions between the monophthongs is discussed in the following chapter.

4.3.1.1 Ach Front Vowels from INT

The scatter plot for [i], [e] and [ɛ] by Ach language consultants in Figure 4.25 shows the position of these vowels as produced by these speakers.

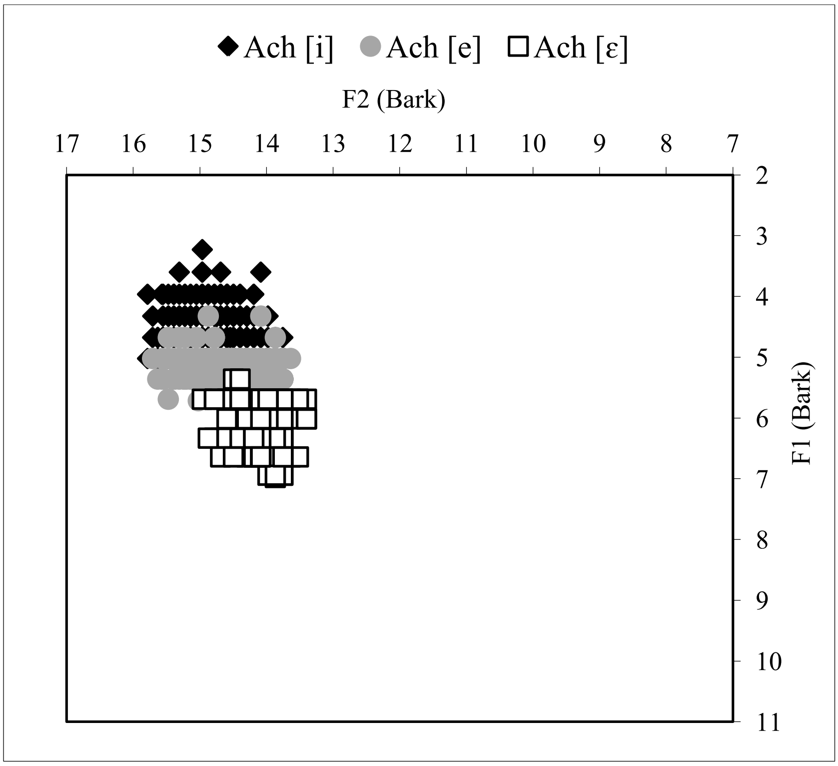


Figure 4.25: Scatter plot of Ach [i], [e] and [ɛ] from INT

Although there are overlaps between [i] and [e], and between [e] and [ɛ], as shown in Figure 4.25, the distinctions between these three vowels were sustained. This was confirmed by t-tests, where significant differences were found in the F1 and F2 average values between [i] and [e] (F1: $t(876)=27$, $p<.0001$; F2: $t(876)=12.76$, $p<.0001$) and between [e] and [ɛ] (F1: $t(529)=29.72$, $p<.0001$; F2: $t(529)=10.76$, $p<.0001$).

4.3.1.2 Ach Central Vowels from INT

The distribution of [ɯ], [ə], [ʌ] and [a] by Ach language consultants is shown in Figure 4.26 and it can be seen that these vowels were produced more centrally in the vowel space compared to their distribution in WE, especially [ɯ] (see Figure 4.1 and Figure 4.5).

A substantial overlap between [ə] and [ʌ] is also seen in Figure 4.26. No t-test could be conducted between these two vowels as the sample for [ə] was *n*<30. However, there is a distinction made between these two vowels by all language consultants. This is represented in Figure 4.27 that displays the scatter plot of [ɯ], [ə], [ʌ] and [a] for Ach7 that shows a distinction between the production of [ə] and [ʌ].

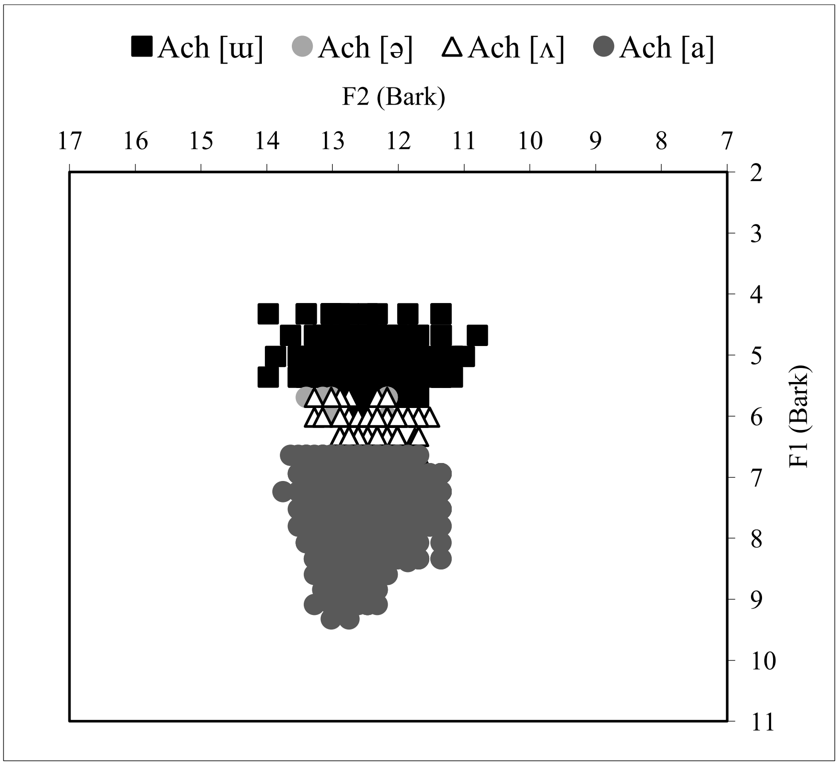


Figure 4.26: Scatter plot of Ach [ɯ], [ə], [ʌ] and [a] from INT

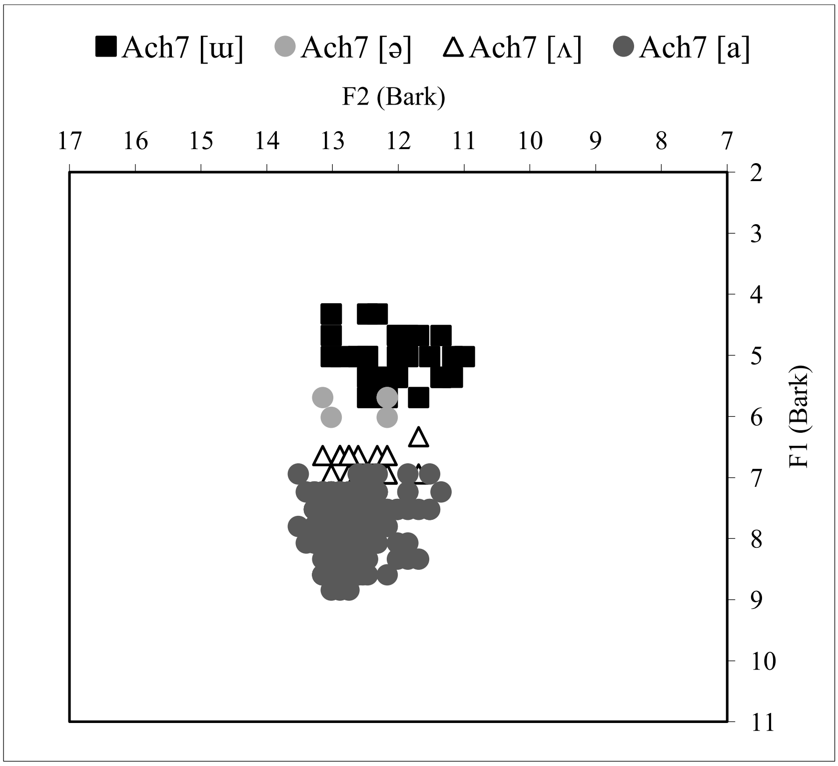


Figure 4.27: Scatter plot of Ach7 [ɯ], [ə], [ʌ] and [a] from INT

4.3.1.3 Ach Back Vowels from INT

Figure 4.28 shows the distribution of [u], [o] and [ɔ] by Ach language consultants in the vowel space. Compared to WE where [u] and [ɔ] are more fronted (see Figure 4.1 and Figure 4.7), thus, INT shows that these two vowels were produced more back, in line with its other back vowel [o]. The back vowels from INT are also seen to be produced more dispersed in the vowel space compared to their productions from WE (see Figure 4.7).

Overlaps are also seen between [u] and [o], and between [o] and [ɔ] in Figure 4.28. T-tests were conducted to further study their productions. Between [u] and [o], there were significant differences found in the F1 average values ($t(340)=17.73$, $p<.0001$) and in the F2 average values ($t(340)=0.39$, $p<.0001$). This indicates that they were produced differently. Between [o] and [ɔ], significant differences were also found in the F1 and F2 average values (F1: t(540)=29.77, p<.0001; F2: t(540)=9.07, p<.0001) and this means that both of these vowels were produced differently.

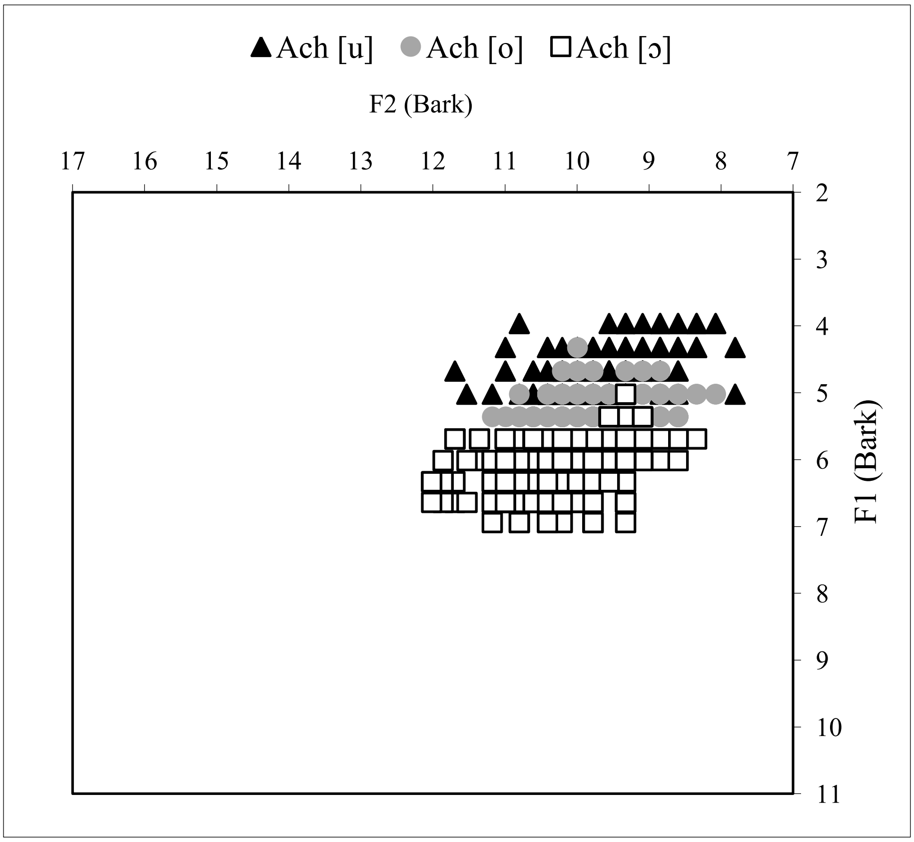


Figure 4.28: Scatter plot of Ach [u], [o] and [ɔ] from INT

4.3.2 KpA Monophthongs from INT

The duration, average formant frequencies and SD (in parentheses) for the F1 and F2 of each vowel produced by KpA language consultants are shown in Table 4.6. ED (in Bark) from the center is also presented in the right columns.

Table 4.6: F1 and F2 Average Values, and SD for KpA Monophthongs

Vowel	Duration (sec)	Ave. F1 and SD (Hz)	Ave. F2 and SD (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)	ED
i	0.098 (0.05)	490 (33.25)	2707 (160.07)	4.65 (0.29)	14.99 (0.35)	3.26
e	0.115 (0.05)	547 (23.97)	2685 (166.20)	5.14 (0.20)	14.94 (0.39)	3.14
ɛ	0.118 (0.06)	650 (49.68)	2493 (173.08)	5.99 (0.39)	14.49 (0.43)	2.76
ɯ	0.120 (0.07)	559 (29.33)	1908 (167.37)	5.24 (0.25)	12.80 (0.58)	0.99
a	0.097 (0.04)	860 (92.66)	1875 (189.20)	7.57 (0.64)	12.69 (0.67)	2.39
ɑ	0.112 (0.04)	770 (54.20)	1436 (61.01)	6.92 (0.40)	10.90 (0.29)	1.81
u	0.099 (0.05)	503 (22.89)	1290 (109.16)	4.76 (0.20)	10.19 (0.57)	1.73
o	0.115 (0.06)	548 (26.56)	1209 (117.65)	5.15 (0.23)	9.75 (0.66)	2.07
ɔ	0.105 (0.05)	648 (47.73)	1278 (120.96)	5.98 (0.38)	10.12 (0.63)	1.80
ə*	0.111 (0.07)	567 (27.60)	1471 (122.40)	5.31 (0.23)	11.07 (0.56)	0.74
Ave.	0.109 (0.01)					2.22 (0.74)

n.b. *all words with central vowel /ə/ was produced more back, closer to [ɵ].

INT further support the findings from WE where /ʌ/ was also absent in the speech of KpA language consultants (see 4.2.2.2 and 4.2.3.6). From this set of data, Acehnese words with /ʌ/ were replaced by [ɛ] and [ɔ], depending on its position in the word environment. In addition, the production of Acehnese words with /a/ was found to be produced in [a] (827 tokens) and [ɑ] (90 tokens) by these language consultants, also depending on its position in the word environment. Further analyses of these vowels are presented in 4.3.3.7.

The plot of formant average values of Acehnese vowels by KpA language consultants are presented in Figure 4.29, which displays the placement of vowels in the vowel space from INT.

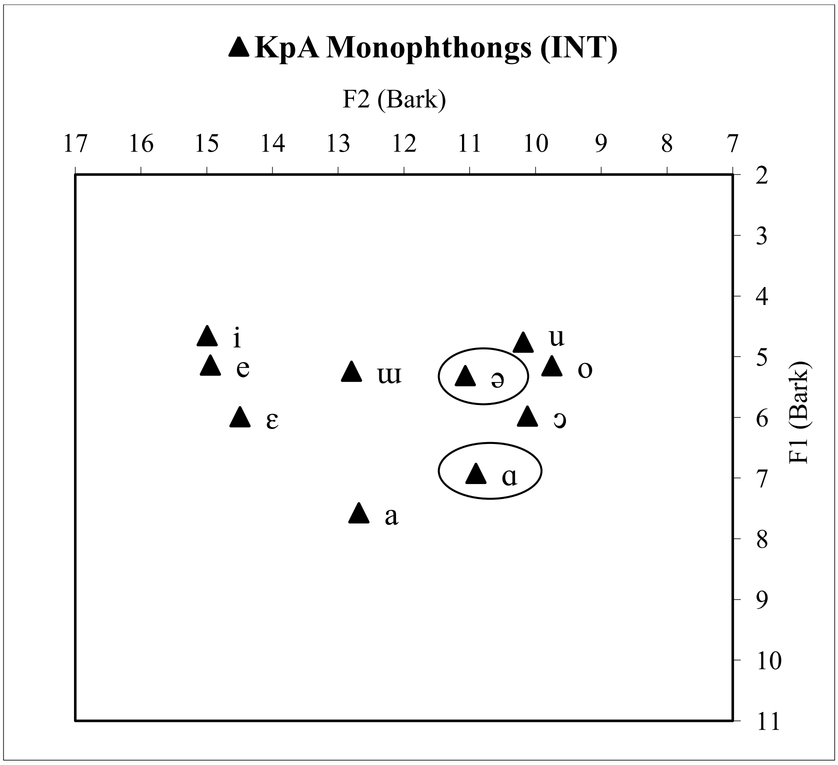


Figure 4.29: Plot of formant average values for KpA monophthongs from INT
n.b. The sound [ɑ] is present and was not detected in WE, and the sound /ə/ was produced closer to [ɵ].

Figure 4.29 further shows the absence of /ʌ/ in KpA monophthongs. This is consistent with the findings from WE where the central vowel /ə/ is also seen to be produced more back by these speakers. The additional sound /ɑ/ is present and this was not detected in WE.

4.3.2.1 KpA Front Vowels from INT

Figure 4.30 shows the scatter plot for [i], [e] and [ɛ] produced by KpA language consultants.

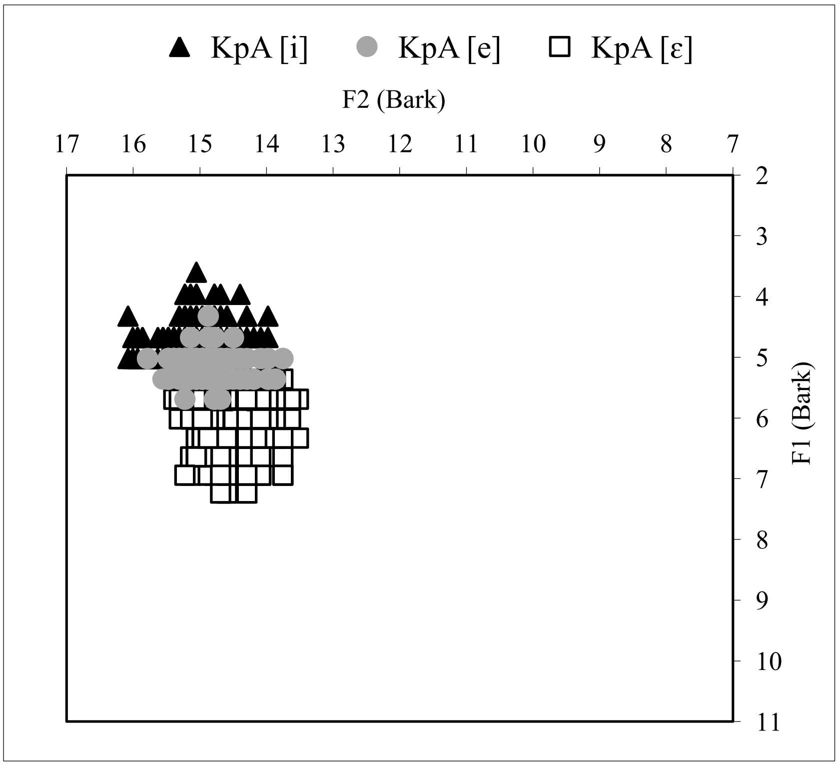


Figure 4.30: Scatter plot of KpA [i], [e] and [ɛ] from INT

Even though some tokens are seen to overlap in Figure 4.30, which implies that they were produced similarly in some instances, thus, t-tests between [i] and [e] showed that a significant difference was found in the F1 average values ($t(475)=19.86$, $p<.0001$), but no significant difference was found in the F2 average values ($t(475)=1.43$, $p=0.077$). This indicates that [e] was produced lower than [i] in the vowel space as seen in Figure 4.30. Between [e] and [ɛ], t-tests showed that significant differences were found in the F1 and F2 average values (F1: $t(540)=26.36$, $p<.0001$; F2: $t(540)=12.44$, $p<.0001$), indicating that these vowels were produced differently.

4.3.2.2 KpA Central Vowels from INT

Figure 4.31 shows the distribution of [ɯ], [ə], [a] and [ɑ] by KpA language consultants in the vowel space. As /ʌ/ is distinct in the vowel space, therefore, only these four vowels appeared to be produced centrally by KpA language consultants with [ə] and [ɑ] to be produced more back compared to the other central vowels.

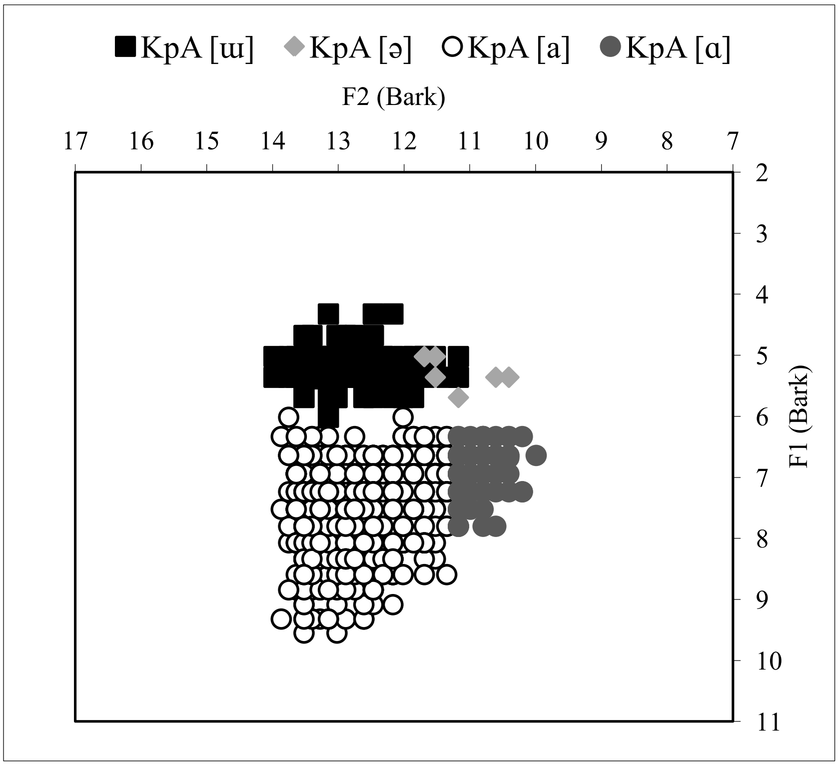


Figure 4.31: Scatter plot of KpA [ɯ], [ə], [a] and [ɑ] from INT

4.3.2.3 KpA Back Vowels from INT

Figure 4.32 shows the distribution of [u], [o] and [ɔ] by KpA language consultants in the vowel space. The positioning of these three vowels in INT is seen to be more back compared to WE where [u] and [ɔ] are more fronted in the vowel space compared to [o] (see Figure 4.8 and Figure 4.13). Overlaps are also seen between [u] and [o], and between [o] and [ɔ]. However, t-tests conducted between [u] and [o] showed that there were significant differences in the F1 and F2 average values (F1: $t(275)=1286$, $p<.0001$; F2: $t(275)=4.95$, $p<.0001$), suggesting that these two sounds were produced differently. A distinction is also found between the production of [o] and [ɔ] as t-tests between them showed significant differences in the F1 and F2 average values (F1: $t(414)=26.45$, $p<.0001$; F2: $t(414)=5.86$, $p<.0001$), indicating two different vowels.

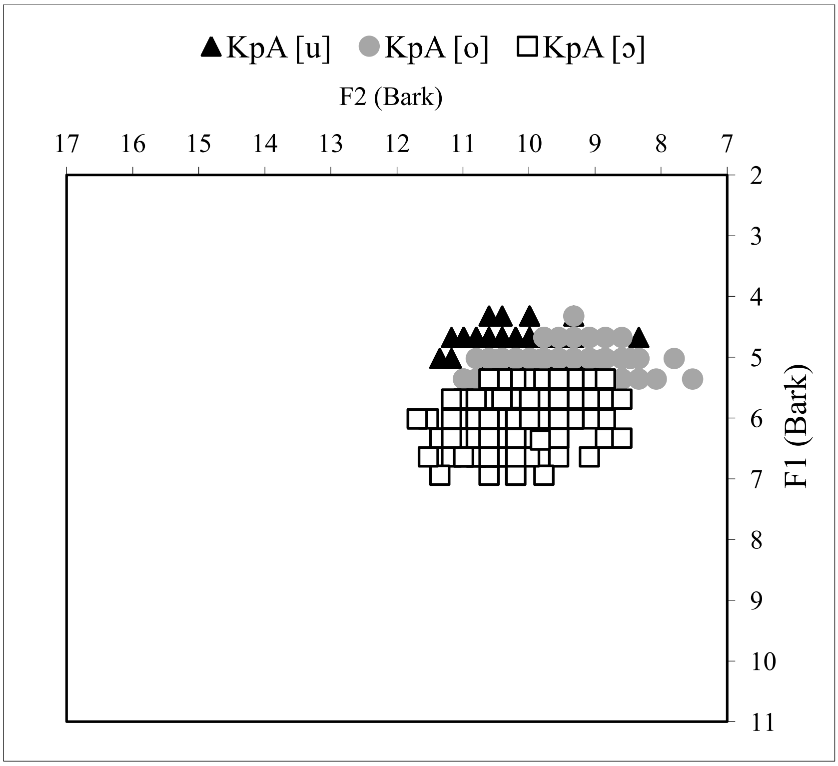


Figure 4.32: Scatter plot of KpA [u], [o] and [ɔ] from INT

4.3.3 Ach vs. KpA Monophthongs from INT

A detailed discussion on the comparison of each vowel between Ach and KpA monophthongs and the outcomes from WE and INT are further discussed in the following 4.3.3.1 until 4.3.3.10. The list and complete number of words selected for the monophthongs and their measurements in Hertz and Bark are provided in Appendix L for Ach language consultants and Appendix M for KpA language consultants.

4.3.3.1 The production of /i/

From INT, Ach [i] is extracted from 468 tokens (see Appendix L.1) while KpA [i] is from 296 tokens (see Appendix M.1) in the words in Table 4.7.

Table 4.7: Words to Elicit /i/

No	Words	Gloss	Ach	KpA
1	*Aj**i**s*	name (male)	✓	
2	*Balk**i**h*	name (female)		✓
3	*b**i**t/keub**i**t*	seriously	✓	
4	*(ureueng) ch**i**k/sh**i**k*	parents, elders	✓	✓
5	*c**i**p*	finish (sewing)		✓
6	*c**i**t/s**i**t*	too, also	✓	✓
7	*h**i**kmah*	wisdom	✓	✓
8	*j**i**h*	she/he/it	✓	✓
9	*keuch**i**k*	chief of the village	✓	✓
10	*krèd**i**t*	credit	✓	
11	*mesj**i**d*	mosque	✓	✓
12	*p**i**h*	too, also	✓	✓
13	*sed**i**h*	sad	✓	
14	*semp**i**t*	cramped	✓	
15	*s**i**p*	seam (sewing)		✓
16	*sunt**i**k*	injection	✓	
17	*syah**i**d*	martyrdom	✓	
18	*ub**i**t*	small, little	✓	
Total number of words			15	10
Total number of tokens			468	296

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [i] is 489 Hz and for KpA [i] is 490 Hz, a t-test between them also showed no significant difference (F1: t(762)=0.61, p=0.271). The average value of F2 for Ach [i] is 2663 Hz, while KpA [i] is 2707 Hz, and the result of a t-test between them also showed no significant difference (t(762)=3.63, p=0.000). The distribution of Ach [i] and KpA [i] are shown in Figure 4.33 that obviously displays an overlap between the productions of these two vowels, therefore, it can be said that they were produced similarly.

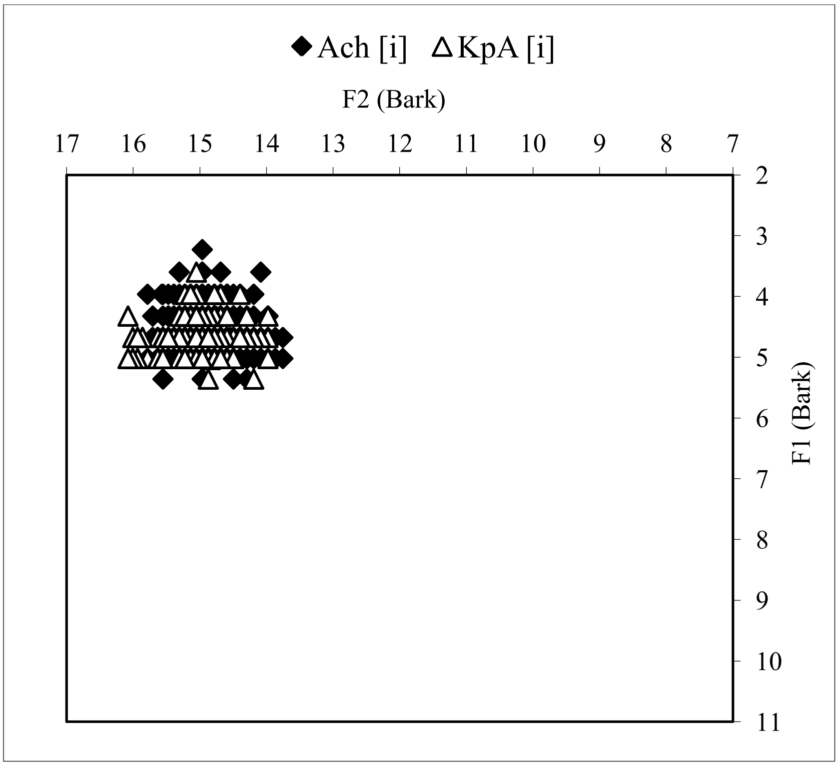


Figure 4.33: Distribution of Ach [i] and KpA [i] from INT

The production of [i] by Ach and KpA language consultants from WE and INT were also examined to study their productions in the different speaking contexts. For Ach [i] from both speaking contexts, t-tests showed a significant difference in the F1 average values (t(496)=7.56, p<.0001), but no significant difference in the F2 average values (t(496)=0.3, p=0.382). However, Figure 4.34 shows that the tokens of Ach [i] from WE and INT are overlapping. Therefore, this suggests that Ach [i] were produced similarly in both speaking contexts.

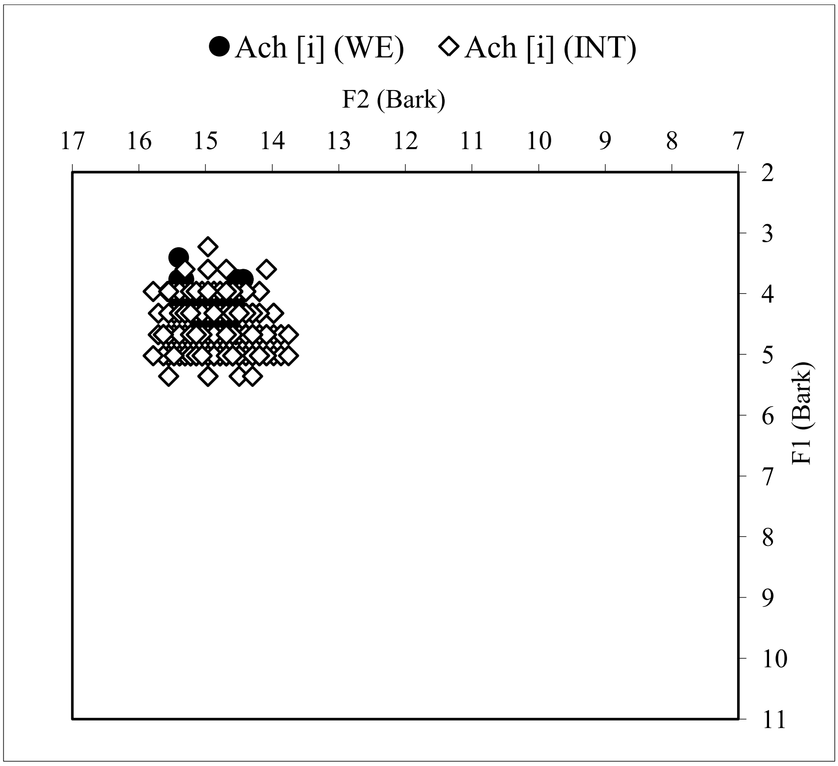


Figure 4.34: Distributions of Ach [i] from WE and INT

Figure 4.35 shows that KpA [i] from WE and INT also overlap each other. Thus, t-tests conducted between the two speaking contexts showed a significant difference in the F1 average values ($t(324)=10.64$, $p<.0001$), but no significant difference in the F2 average values ($t(324)=2.24$, $p=0.013$). This suggests that KpA [i] from WE was produced higher than INT.

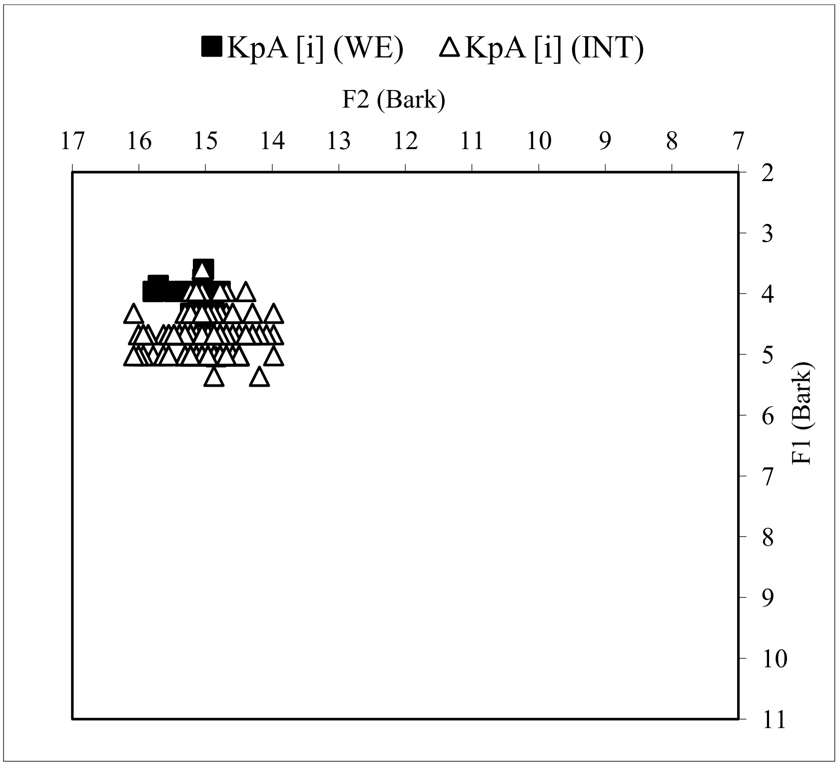


Figure 4.35: Distributions of KpA [i] from WE and INT

4.3.3.2 The production of /e/

A total of 410 tokens for Ach [e] (see Appendix L.2) and 181 tokens of KpA [e] (see Appendix M.2) were obtained in the words in Table 4.8 from INT.

Table 4.8: Words to Elicit /e/

No	Words	Gloss	Ach	KpA
1	*abéh*	demolished, finished	✓	✓
2	*adék/dék*	younger sibling	✓	✓
3	*Anték*	name (female)	✓	
4	*bangkét*	get up	✓	
5	*bintéh*	wall	✓	
6	*blah déh*	on the other side	✓	✓
7	*Cadék*	name (of village)	✓	
8	*canték*	beautiful	✓	
9	*cék*	aunty/uncle	✓	✓
10	*jéh*	that	✓	✓
11	*jép*	drink	✓	

‘Table 4.8, continued’

12	*keudéh*	over there	✓	✓
13	*kutép*	collect		✓
14	*lapéh*	layer	✓	✓
15	*lapék*	cover		✓
16	*latéh*	train		✓
17	*lukéh*	paint, draw		✓
18	*meucéh*	must	✓	
19	*meudéh*	accordingly, like that, should	✓	✓
20	*patéh*	believe, trust	✓	✓
21	*péh*	grind		✓
22	*perséh*	exactly	✓	
23	*peudéh*	painful	✓	
24	*picét*	squished	✓	
25	*putéh*	white	✓	✓
26	*puték*	papaya		✓
27	*sakét*	sick	✓	✓
28	*sék*	cut		✓
29	*sép*	enough	✓	
30	*seupét/ceupét*	stuck, pinch	✓	
31	*sidéh*	over there	✓	✓
32	*sungkét*	gouged	✓	
33	*tapéh*	brush (made from coconut shell)		✓
34	*tindéh*	overlap	✓	
35	*titép*	left at one	✓	
36	*ratéb*	prayer	✓	
37	*rumoh sakét*	hospital	✓	
38	*udép*	life	✓	✓
Total number of words			30	21
Total number of tokens			410	181

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [e] is 555 Hz and KpA [e] is 547 Hz. Furthermore, the average value of F2 for Ach [e] is 2516 Hz and KpA [e] is 2685 Hz. T-tests indicated that there was no significant difference in the F1 average values (t(589)=3.4, p=0.000) but a significant difference in the F2 average values (t(589)=11.12, p<.0001). However, looking at the scatter plot of [e] from both groups of language consultants in Figure 4.36, the distribution overlap and suggests that they were produced similarly.

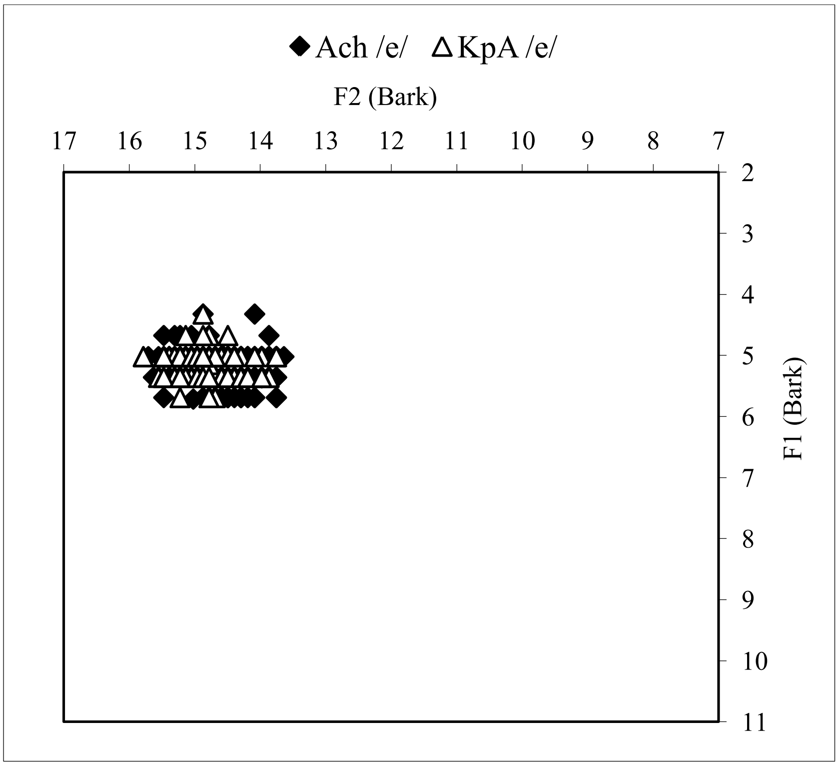


Figure 4.36: Distribution of Ach [e] and KpA [e] from INT

Figure 4.37 presents the scatter plot of Ach [e] from WE and INT where tokens from WE are seen to be produced higher than INT. T-tests also showed a significant difference in the F1 average values (t(438)= 9.45, p<.0001), but no significant difference in the F2 average values (t(438)=0.05, p=0.480).

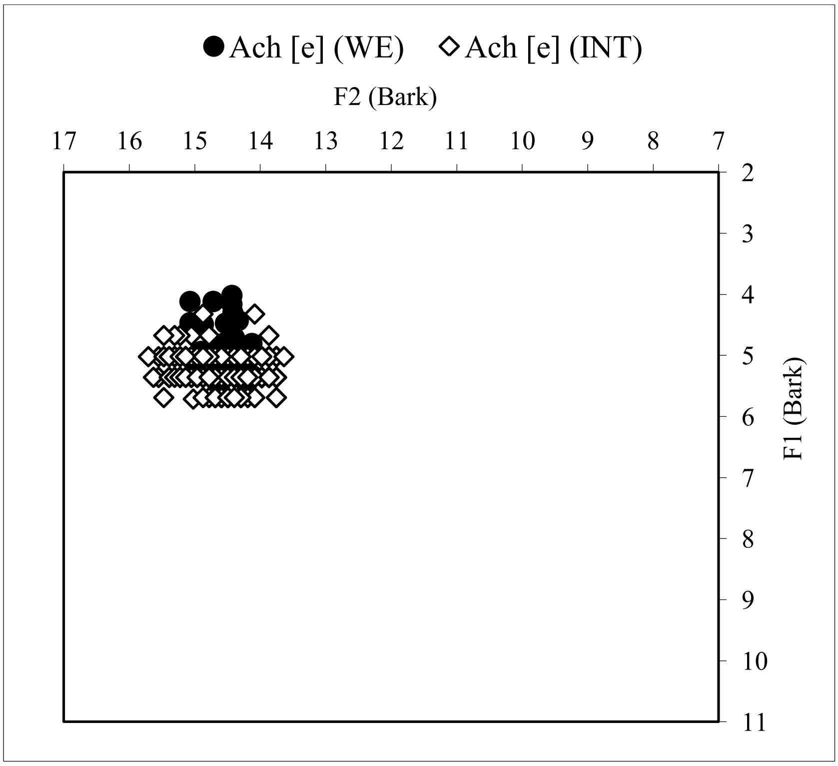


Figure 4.37: Distributions of Ach [e] from WE and INT

Subsequently, the distribution of KpA [e] from WE and INT is displayed in Figure 4.38. T-tests between the two speaking contexts indicated a significant difference in the F1 average values ($t(209)=12.48$, $p<.0001$), but no significant difference in the F2 average values ($t(209)=0.6$, $p=0.275$). Figure 4.38 also illustrates that the production of KpA [e] from WE is higher than INT.

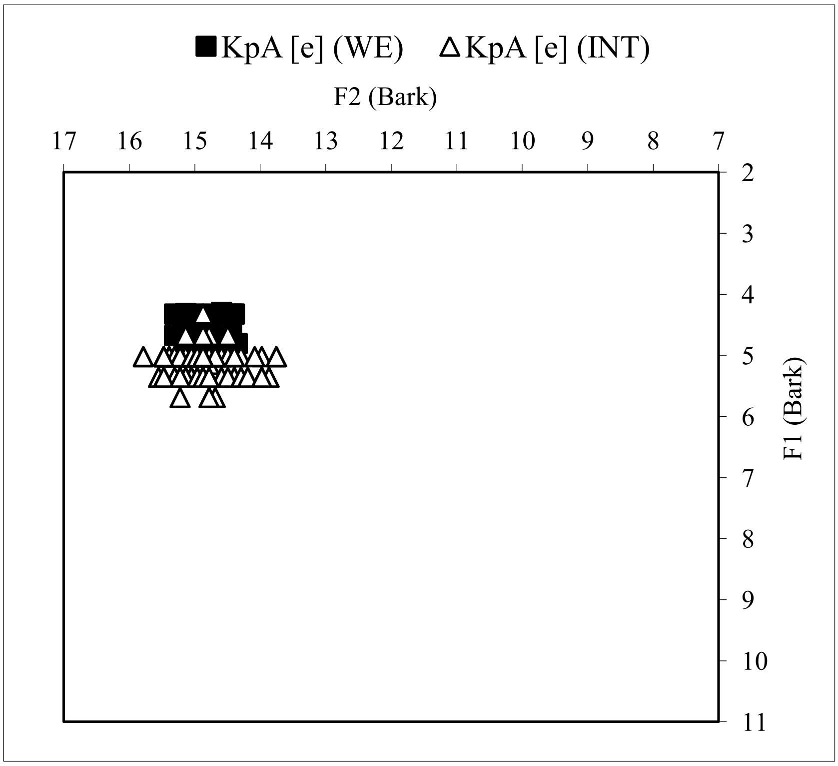


Figure 4.38: Distributions of KpA [e] from WE and INT

4.3.3.3 The production of /ɛ/

A number of 121 tokens of Ach [ɛ] (see Appendix L.3) and another 361 tokens of KpA [ɛ] (see Appendix M.3) were measured in the words in Table 4.9 from INT.

Table 4.9: Words to Elicit /ɛ/

No	Words	Gloss	Ach	KpA
1	*Acèh*	name (of province)	✓	✓
2	*Banda Acèh*	name (of city)	✓	✓
3	*Basa Acèh*	Acehnese language		✓
4	*bèk*	no	✓	✓
5	*cèk*	check, cheque		✓
6	*cukèh*	poke	✓	
7	*deumpèt*	stuck	✓	
8	*dompèt*	purse	✓	
9	*èsèt*	capital		✓
10	*gèt*	good, fine		✓
11	*hèk*	tired	✓	✓

‘Table 4.9, continued’

12	*jadèh*	be, agree, proceed	✓	
13	*Kampông Acèh*	name (of village)		✓
14	*karpèt*	carpet, rug	✓	
15	*Lambaro Skèp*	name (of village)	✓	
16	*Lampasèh*	name (of village)	✓	
17	*leubèh*	more, additional	✓	✓
18	*pèspa*	motorcycle	✓	
19	*macèt*	heavy traffic	✓	
20	*pakèk*	wear	✓	
21	*pèh*	hit, pound	✓	✓
22	*pasèh*	fluent		✓
23	*peugèt*	make, produce		✓
24	*sahèh*	trusted		✓
25	*seutèt*	follow, find		✓
26	*singkèk*	walk slowly	✓	
27	*tèksi*	taxi		✓
28	*tikèt*	ticket		✓
Total number of words			17	17
Total number of tokens			121	361

n.b. ✓ means the group of speakers produced the word.

From INT, the average value of F1 for Ach [ɛ] is 658 Hz and KpA [ɛ] is 650 Hz; and a t-test between them also confirmed no significant difference in the F1 average values ($t(480)=1.65$, $p=0.050$). The average value of F2 for Ach [ɛ] is 2335 Hz and KpA [ɛ] is 2493 Hz, and a t-test between them showed a significant difference in the F2 average values ($t(480)=9.17$, $p<.0001$). However, the scatters plot in Figure 4.39 shows that Ach [ɛ] and KpA [ɛ] overlap, indicating that they were produced in a similar way.

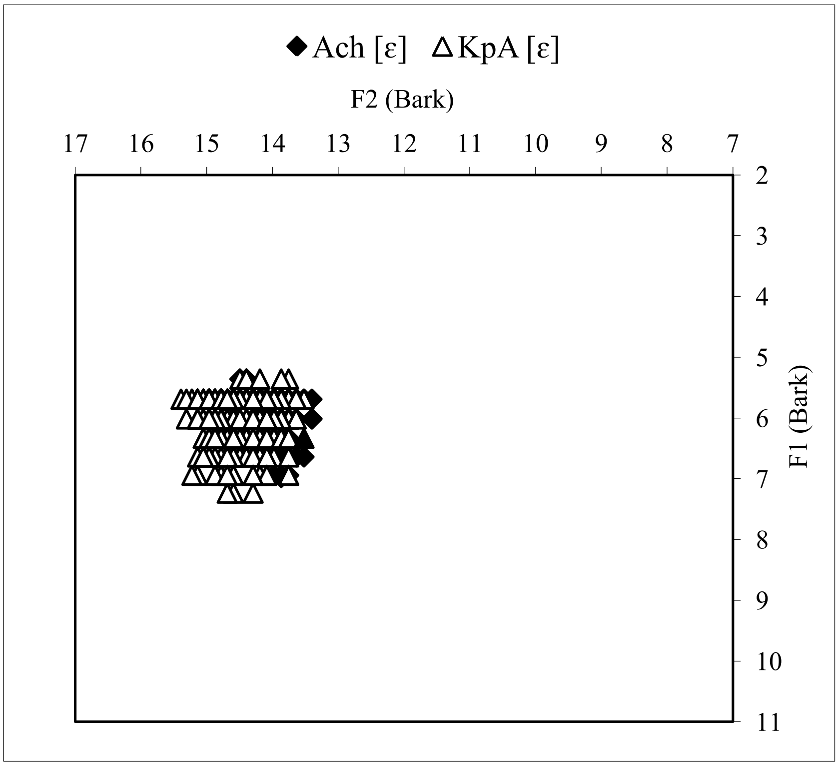


Figure 4.39: Distribution Ach [ɛ] and KpA [ɛ] from INT

Figure 4.40 demonstrates that tokens of Ach [ɛ] from WE are seen to be scattered higher in the vowel space compared to INT. However t-tests between the two speaking contexts showed no significant differences in the F1 and F2 average values (F1: t(149)=2.77, p=0.003; F2: t(149)=1.94, p=0.027), therefore, this sound was produced similarly in both speaking contexts.

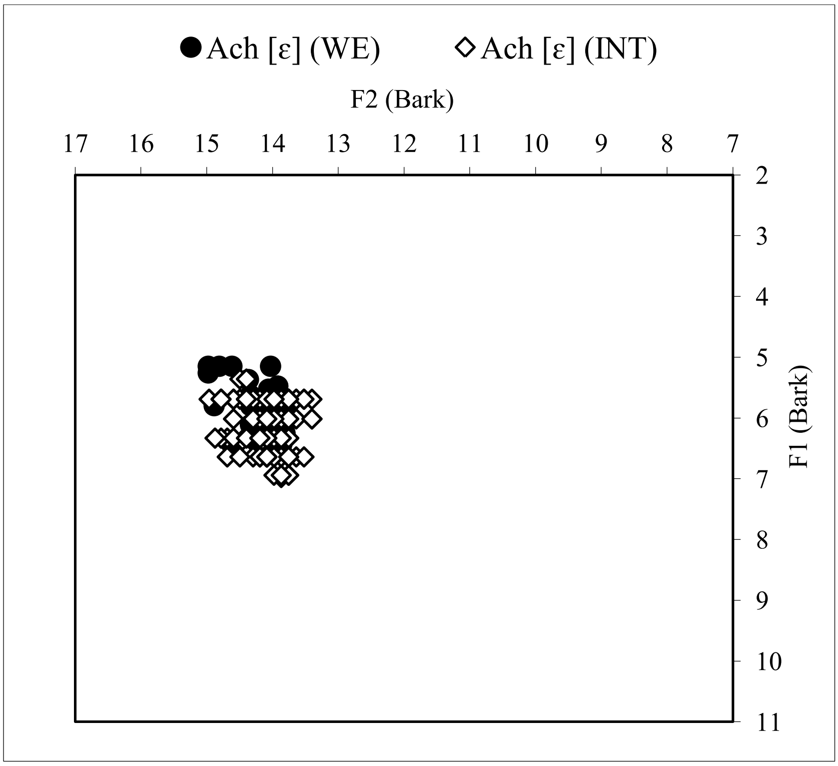


Figure 4.40: Distributions of Ach [ɛ] from WE and INT

Figure 4.41 shows the distribution of KpA [ɛ] from WE and INT. A t-test could not be conducted as KpA [ɛ] from WE had samples of n<30 (see 4.2). Thus, Figure 4.41 clearly shows overlapping tokens between both speaking contexts, which indicates a lack of contrast between them. This denotes that KpA [ɛ] from WE and INT were produced similarly.

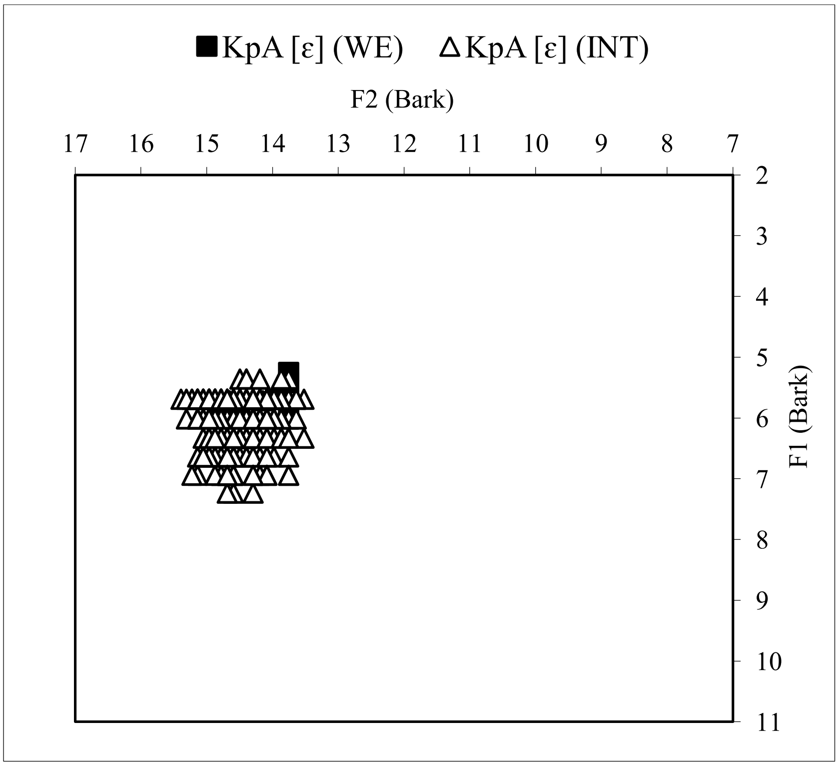


Figure 4.41: Distributions of KpA [ɛ] from WE and INT

4.3.3.4 The production of /ɯ/

From INT, a number of 261 tokens were used to analyze the sound /ɯ/ by Ach language consultants (see Appendix L.4) and 184 tokens by KpA language consultants (see Appendix M.4) from the words in Table 4.10.

Table 4.10: Words to Elicit /ɯ/

No	Words	Gloss	Ach	KpA
1	*unt**euk**/t**euk***	later, so	✓	✓
2	*g**euh***	enclitic for third person	✓	✓
3	*kak**euh***	so, to let it be	✓	
4	*k**euh***	so	✓	✓
5	*p**eu**t*	four	✓	✓
6	*s**eu**k*	move/scoot (over)	✓	
7	*t**eu**k*	more, once again, so	✓	
Total number of words			7	4
Total number of tokens			261	184

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [ɯ] is 550 Hz, while KpA [ɯ] is 559 Hz. A t-test between them showed no significant difference in the F1 average values ($t(443)=2.55$, $p=0.006$). The average value of F2 for Ach [ɯ] is 1820 Hz, while KpA [ɯ] is 1908 Hz and a t-test between them also showed a significant difference in the F2 average values ($t(443)=5.71$, $p<.0001$). However, Figure 4.42 displays their distribution and how they overlap. This suggests that both were produced similarly.

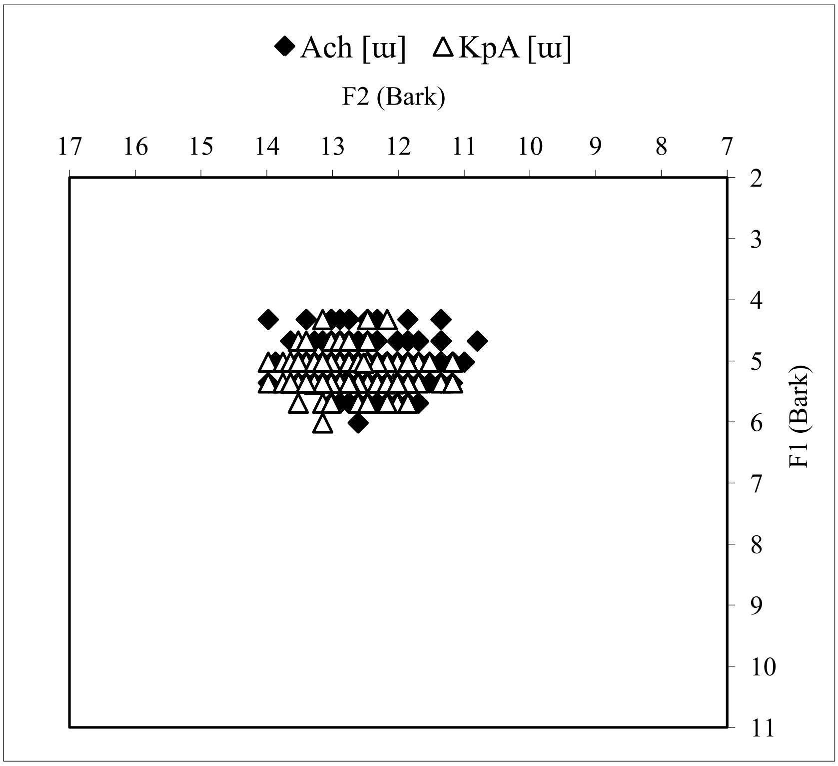


Figure 4.42: Distribution of Ach [ɯ] and KpA [ɯ] from INT

As mentioned earlier in 4.3.1.2, Ach [ɯ] from INT was seen to be plotted more centrally in the vowel space compared to WE. This is substantiated by t-tests conducted between the two speaking contexts that showed significant differences in the F1 and F2 average values (F1: $t(289)=9.81$, $p<.0001$; F2: $t(289)=6.63$, $p<.0001$). Figure 4.43 further presents their distribution where the tokens from WE are seen more fronted compared to INT.

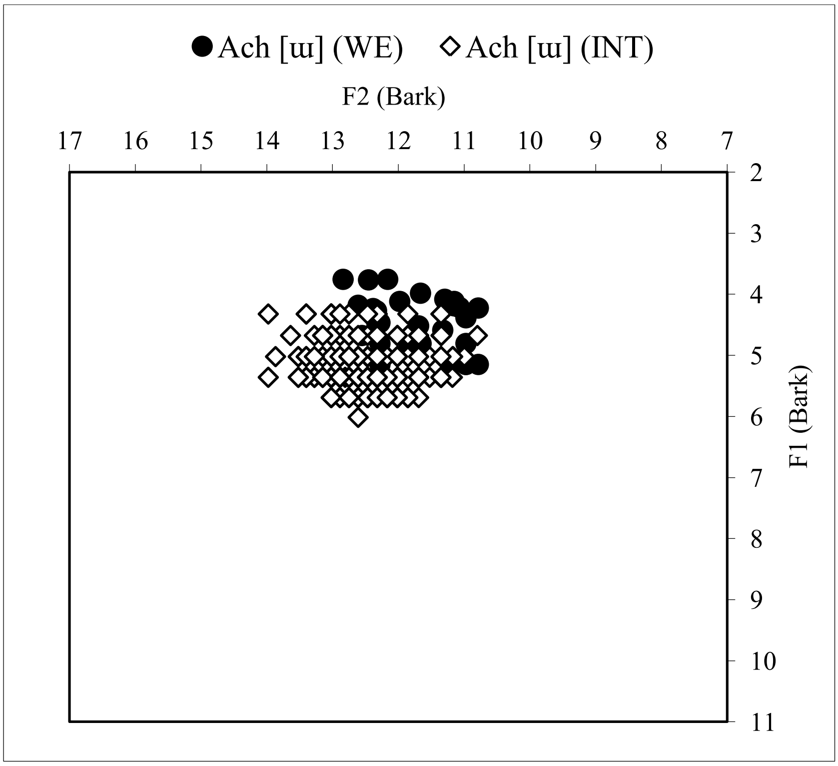


Figure 4.43: Distribution of Ach [ɯ] from WE and INT

As for KpA [ɯ], t-tests between INT and WE indicated a significant difference in the F1 average values ($t(212)=13.67$, $p<.0001$), but no significant difference in the F2 average values ($t(212)=0.51$, $p=0.305$). This implies that KpA [ɯ] from WE was produced higher than that from INT and this is illustrated from their distribution in Figure 4.44.

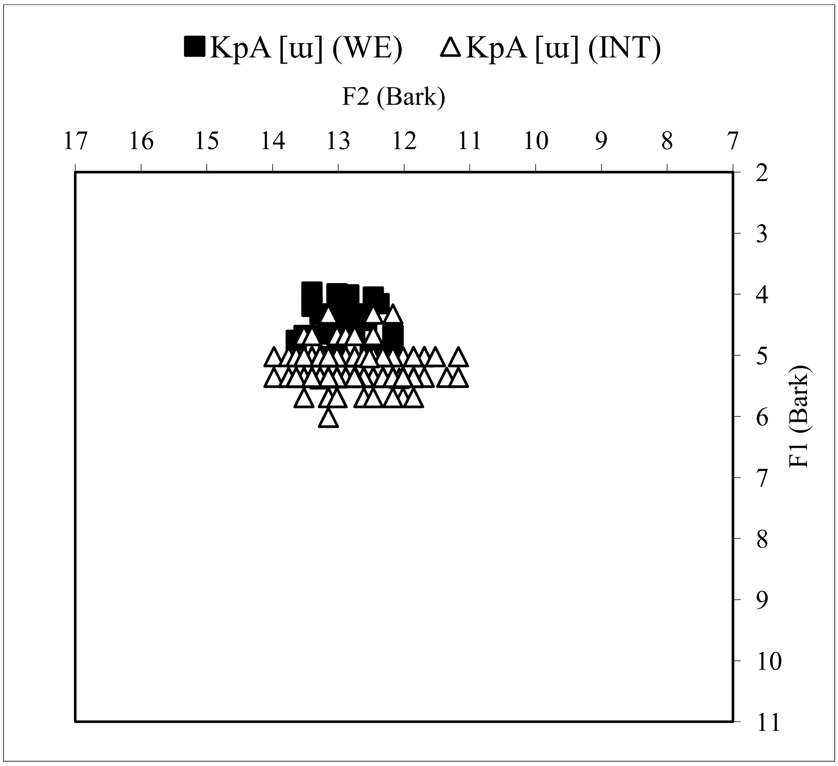


Figure 4.44: Distribution of KpA /ɯ/ from WE and INT

4.3.3.5 The production of /ə/

Many words in the CVC environment where C is a stop or fricatives were not found in INT for /ə/ compared to the other monophthongs. Only eight tokens of /ə/ were selected from Ach language consultants (see Appendix L.5) and another seven tokens of /ə/ from KpA language consultants (see Appendix M.5) from the words in Table 4.11.

Table 4.11: Words to Elicit /ə/

No	Words	Gloss	Ach	KpA
1	*bes*	bus	✓	
2	*chet/cet*	catch	✓	
3	*teukeujet*	surprise	✓	✓
4	*tet*	burn		✓
Total number of words			3	2
Total number of tokens			8	7

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [ə] is 623 Hz and KpA [ə] is 567 Hz, and the average value of F2 for Ach [ə] is 1874 Hz and KpA [ə] is 1471 Hz. As the samples from both language consultants were n<30, therefore, no t-test could be conducted on this vowel from INT. Figure 4.45 shows the distribution of [ə] by Ach and KpA language consultants and it clearly illustrates that KpA language consultants had produced this vowel more back, representing [ɵ] in which lip rounding by these language consultants was noticed during the interview recordings.

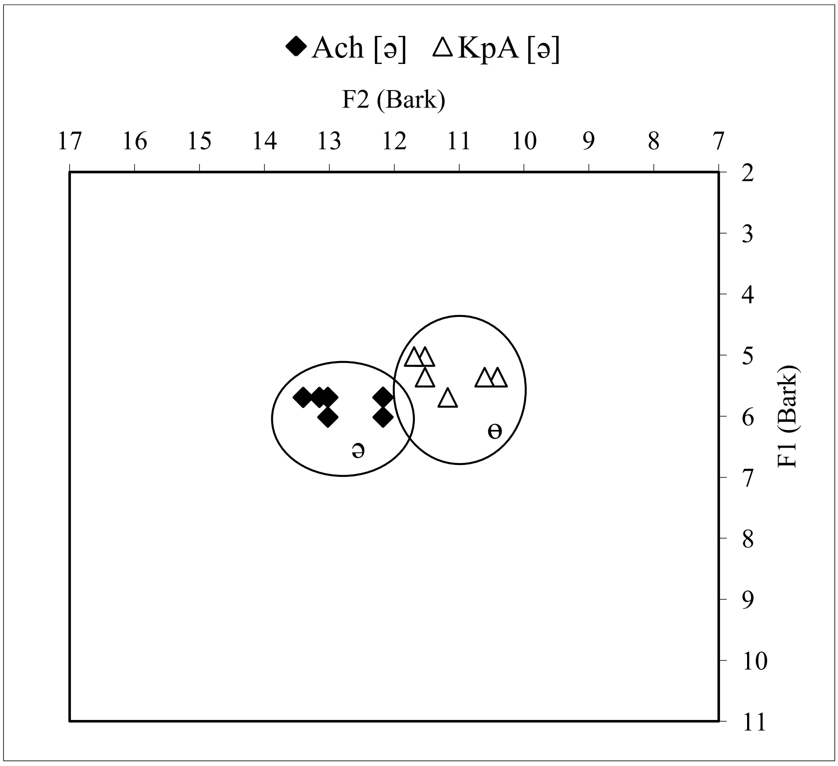


Figure 4.45: Distribution of Ach [ə] and KpA [ə] from INT
n.b. /ə/ is realized closer to [ɵ] KpA language consultants.

For Ach [ə] from WE and INT, Figure 4.46 shows the distribution of [ə] from WE are higher than that from INT.

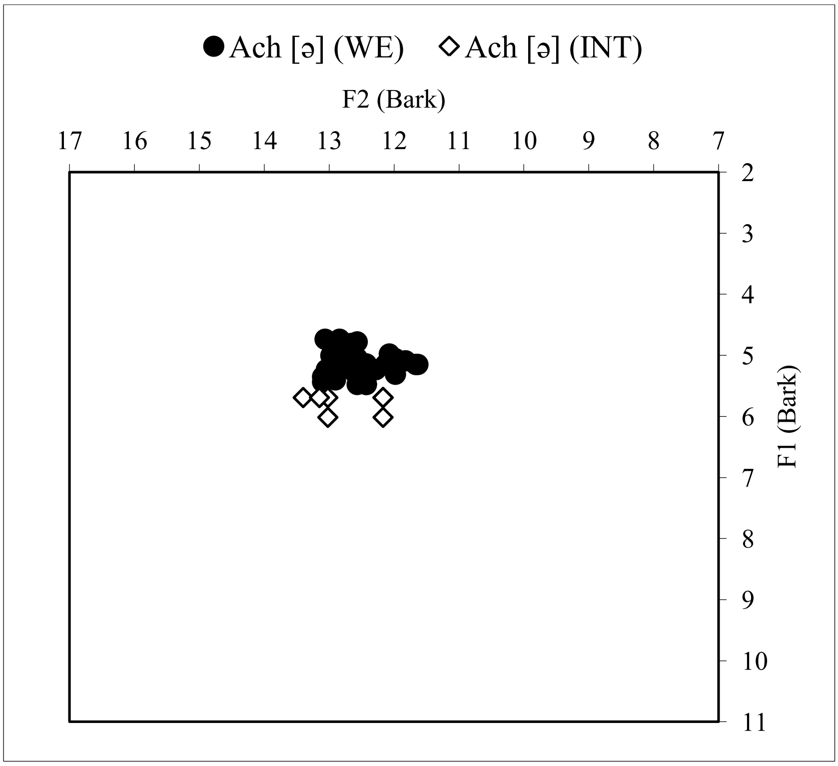


Figure 4.46: Distributions of Ach [ə] from WE and INT

For /ə/ by KpA language consultants, both WE and INT suggest that it was realized as [ɵ] and this is represented in Figure 4.47. The scatter plot for [ɵ] from WE, however, is seen to be higher than those from INT.

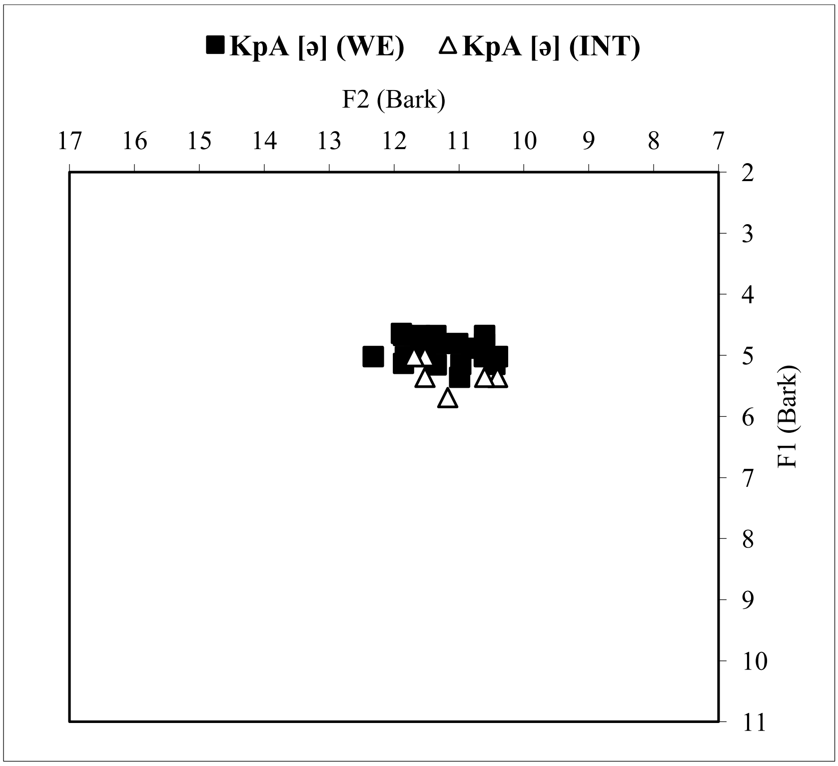


Figure 4.47: Distributions of KpA [ə] from WE and INT
n.b. /ə/ is realized closer to [ɵ] by KpA language consultants from both contexts.

4.3.3.6 The production of /ʌ/

As both groups of language consultants posed variability in the production of /ʌ/ from WE as explained in 4.2.1.2 and 4.2.2.2, this was also the case from INT. Therefore, they are each discussed separately in the following sections (a) and (b).

(a) The production of /ʌ/ by Ach language consultants

From INT, a number of 96 tokens of /ʌ/ from Ach language consultants (see Appendix L.6) were measured in the words in Table 4.12.

Table 4.12: Words to Elicit /ʌ/

No	Words	Gloss
1	*beudöh*	get up, wake up
2	*böh*	dispose, discard, throw away
3	*gadöh*	lost, missing
4	*göt*	good, fine
5	*khöt*	shiver
6	*peugöt*	make, produce
7	*seutöt*	find, follow
8	*söt*	as previously
9	*töh*	(which) one
Total number of words		9
Total number of tokens		96

Interestingly, two language consultants, Ach5 and Ach8, who had pronounced the word *göt* with [ɛ] in WE, had produced all instances of this word in INT with [ʌ]. The number of tokens and occurrences of [ʌ] in their speech can be seen in Table 4.13.

Table 4.13: Ach5 and Ach8 [ʌ] from INT

No	Ach5 and Ach 8 /ʌ/	Word	Gloss	Time	Dur. (sec)	F1 (Hz)	F2 (Hz)	F1 (Bark)	F2 (Bark)
1	Ach5	*seutöt*	find	398.223	0.083	693	1894	6.33	12.75
2	Ach5	*seutöt*	find	407.264	0.078	693	1934	6.33	12.89
3	Ach5	*seutöt*	find	552.769	0.076	733	1934	6.64	12.89
4	Ach5	*göt*	good	759.598	0.129	693	1854	6.33	12.61
5	Ach5	*göt*	good	761.711	0.299	693	1814	6.33	12.47
6	Ach5	*beudöh*	get up	859.968	0.121	653	1814	6.02	12.47
7	Ach8	*beudöh*	get up	41.969	0.095	653	1734	6.02	12.17
8	Ach8	*peugöt*	make	357.935	0.072	693	1734	6.33	12.17
9	Ach8	*göt*	good	700.502	0.241	653	1614	6.02	11.69
Average					0.133	684	1814	6.26	12.45
STANDARD DEVIATION					0.08	26.67	105.83	0.21	0.39

The average values of F1 and F2 in Hertz in Table 4.13 indicate that Ach5 and Ach8 produced the target vowel in the words akin to [ʌ]. As previously reported in 4.2.3.6, the F1 average value of [ʌ] from WE is 710 Hz and the F2 average value is 1806 Hz. Nevertheless, t-test could not be conducted between its production by Ach5 and Ach8 from WE and INT because both had samples of n<30. Figure 4.48, on the other hand, displays their overlapping distribution that suggests all words with [ʌ] by Ach5 and Ach8 from INT were produced similarly with all productions of [ʌ] from WE.

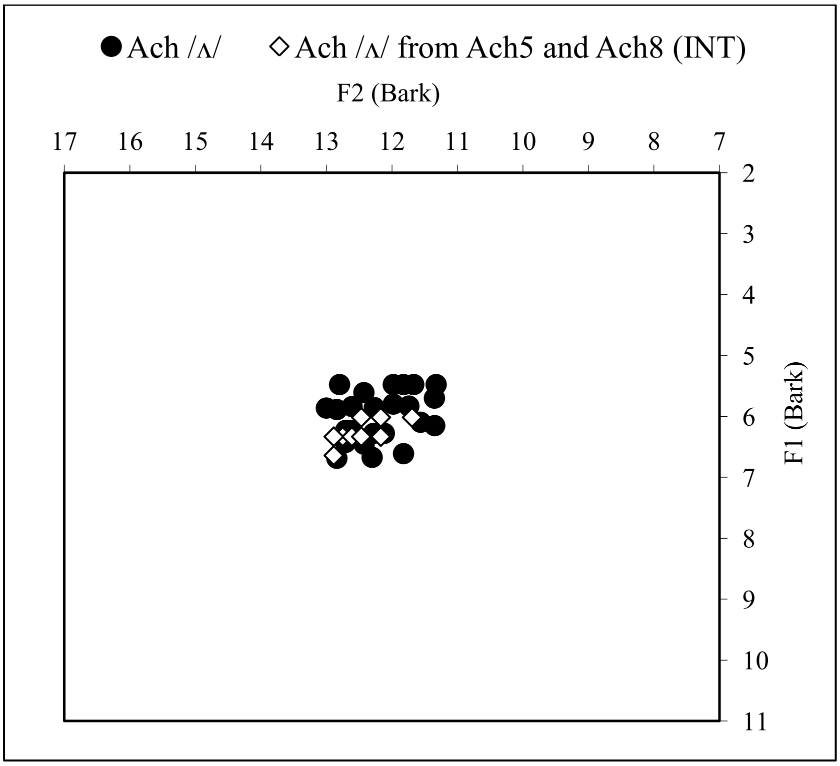


Figure 4.48: Ach [ʌ] from WE and Ach5 and Ach8 from INT

Figure 4.49 further shows tokens of Ach [ʌ] from WE and INT. T-test could not be conducted as the samples of Ach [ʌ] from WE was n<30. Nonetheless, the overlapping distribution shown in Figure 4.49 indicates that [ʌ] from WE was produced quite similarly to those from INT.

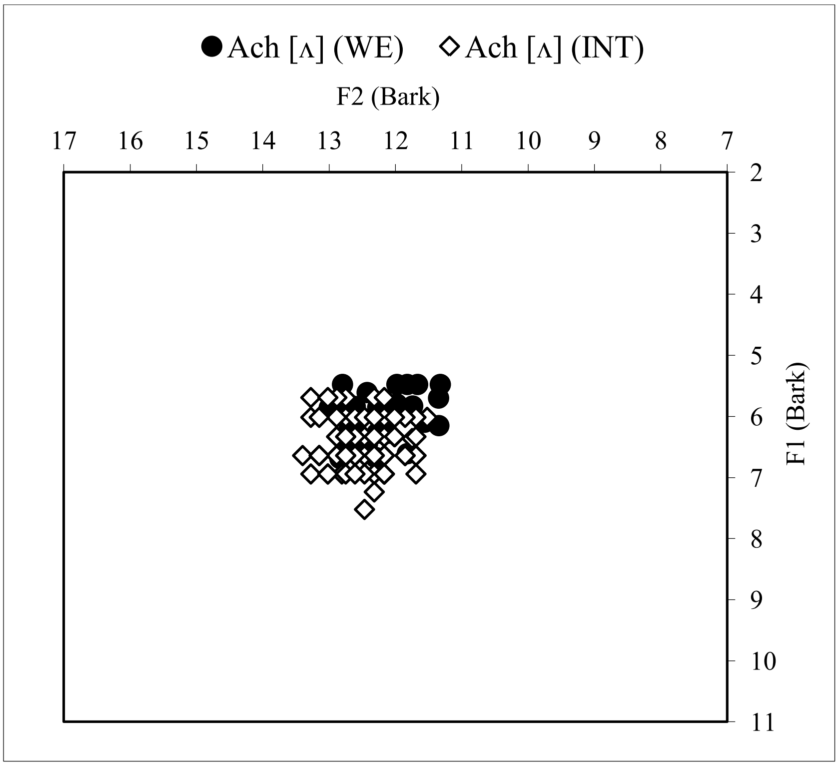


Figure 4.49: Distribution of Ach [ʌ] from WE and INT

(b) The production of /ʌ/ by KpA language consultants

As discussed in 4.2.2.2 and 4.2.3.6, the vowel /ʌ/ from the target word *göt*, did not appear in WE by KpA language consultants. This word was produced with [ɛ] and [ɔ] instead. Again, INT also showed similar findings. All instances of *göt* in INT were produced by these language consultants as *gèt* with [ɛ] (35 tokens), along with two others words found in the data: *peugöt* 'make, produce' and *seutöt* 'find, follow' that were produced as *peugèt* (121 tokens) and *seutèt* (7 tokens), respectively. Interestingly, KpA3 who in WE had pronounced *göt* as *got* with [ɔ], had pronounced all instances of this word as *gèt* with [ɛ] in INT.

Table 4.14: Words to Elicit /ʌ/ but Produced as [ɛ]

No	Words	Produced as	Gloss
1	*g**ö**t*	*g**è**t*	good, fine
2	*peug**ö**t*	*peug**è**t*	make, produce
3	*seut**ö**t*	*seut**è**t*	as previously
Total number of words			3
Total number of tokens			163

Furthermore, the average value of F1 from KpA [ɛ] from *gèt*, *peugèt* and *seutèt* (163 tokens altogether) is 646 Hz and the average value of its F2 is 2485 Hz. T-tests between these values were conducted with the values of KpA [ɛ] from WE (see Appendix J.3), and the results showed a significant difference in the F1 average values (t(191)=5.75, p<.0001), but no significant difference in the F2 average values (t(191)=0.12, p= 0.452). Another t-test was also conducted between KpA [ɛ] from *gèt*, *peugèt* and *seutèt* (163 tokens altogether) with the rest of KpA [ɛ] from INT, and the results showed no significant differences in the F1 and F2 average values (F1: t(358)=1.18, p=0.119; F2: t(358)=0.65, p=0.258). In conclusion, KpA language consultants produced [ɛ] in these words similarly; with [ɛ] from WE produced a little higher than those from INT as shown in its distribution in Figure 4.50.

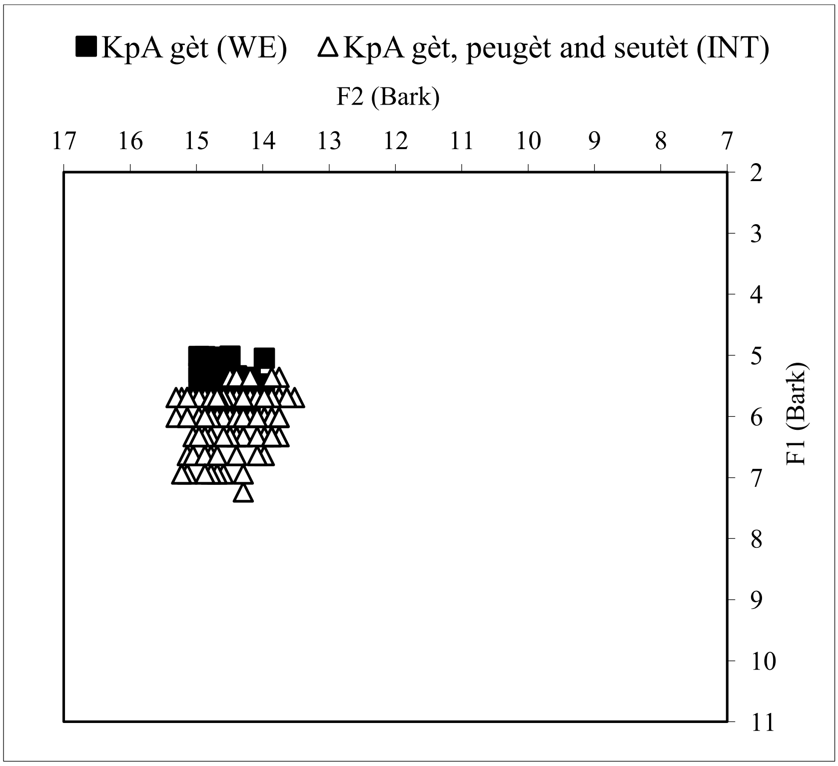


Figure 4.50: Distribution of KpA [ɛ] in *gèt* from WE and *gèt, peugèt* and *seutèt* from INT

Other words in the data, which were produced with [ʌ] by Ach language consultants, such as *böh* 'dispose, discard, throw away', *gadöh* 'lost, missing' and *töh* '(which) one', were all produced with [ɔ] by KpA language consultants and became *boh* (7 tokens), *gadoh* (1 token) and *toh* (10 tokens), respectively.

Table 5.13: Words to Elicit /ʌ/ but Produced as [ɔ]

No	Words	Produced as	Gloss
1	*b**ö**h*	*b**o**h*	dispose, discard, throw away
2	*gad**ö**h*	*gad**o**h*	lost, missing
3	*t**ö**h*	*t**o**h*	(which) one
Total number of words			3
Total number of tokens			18

From KpA [ɔ] for *boh*, *gadoh* and *toh*, the F1 average value is 662 Hz and the F2 average value is 1347 Hz. As the samples was *n*<30, therefore, t-test with KpA [ɔ] from WE could not be conducted. Figure 4.51 shows the distribution of KpA [ɔ] from *toh*, *gadoh* and *boh* with the rest of the [ɔ] production from WE, and overlap is seen in their distribution. This concludes that [ɔ] was produced similarly in both speaking contexts.

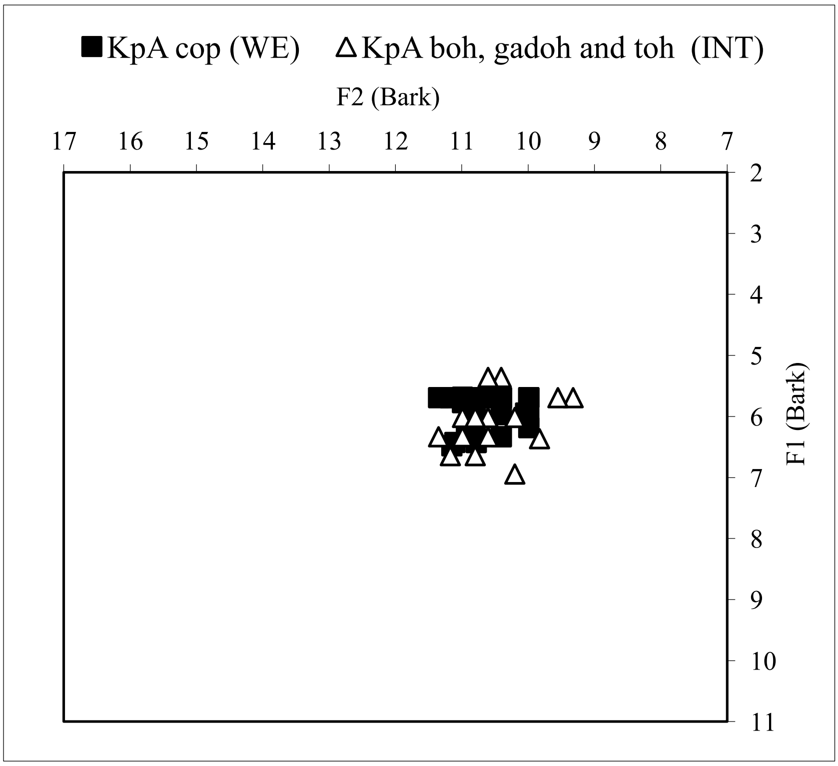


Figure 4.51: Distribution of KpA [ɔ] in *cop* from WE and *boh, gadoh* and *toh* from INT

Based on the findings above, it was assumed that KpA language consultants did not have /ʌ/ in their Acehnese. This sound seems to have been replaced by [ɛ] and [ɔ], depending on its position in the word environment. Based on the findings from WE and INT in this study, the general pattern of occurrence for the variant of Acehnese words with /ʌ/ by KpA language consultants can be summarized as the following:

Occurrence 1: /ʌ/ is produced as [ɛ] when it occurs in the position of CVC in:

- /g/ - /t/, for example from data:

  Ach ***göt*** [gʌt] → KpA ***gèt*** [gɛt]

  Ach *peu**göt*** [pɯgʌt] → KpA *peu**gèt*** [pɯgɛt]

- /t/ - /t/, for example from data:

  Ach *seu**töt*** [sɯtʌt] → KpA *seu**tèt*** [sɯtɛt]

Occurrence 2: /ʌ/ is produced as [ɔ] when it occurs in the position of CVC in:

- starts with /b/ and ends with /h/, for example from data:

  Ach ***böh*** [bʌh] → KpA ***boh*** [bɔh]

- starts with /d/ and ends with /h/, for example from data:

  Ach *ga**döh*** [gadʌh] → KpA *ga**doh*** [gadɔh]

- starts with t/ and ends with /h/, for example from data:

  Ac*h* ***töh*** [tʌh] → Kp*A* ***toh*** [tɔh]

At length, it was also observed that Ach language consultants distinguished the production of *böh* 'dispose, discard, throw away' with [ʌ], and *boh* 'fruit, amount' with [ɔ]. This can be seen in INT where they said all instances of *boh* 'fruit, amount' with [ɔ]. However, since KpA language consultants was assumed to have lost the realization of /ʌ/ from both sets of data, therefore, the two words were both similarly pronounced with [ɔ]. The meanings were distinguished in the speaking contexts by these language consultants.

4.3.3.7 The production of /a/

It was found that KpA language consultants showed variability in the production of /a/ in INT, which was the fronted [a] and back [ɑ] and this was not identified in WE where /a/ was extracted only from one word, *pat* 'where', respectively. The [a] production by Ach and KpA language consultants is discussed in the following section (a), while the [ɑ] production by KpA language consultants is discussed in the next section (b).

(a) The production of /a/ by Ach and KpA language consultants

A total of 1164 tokens from INT were used to analyze the sound /a/ by Ach language consultants (see Appendix L.7) and 827 tokens by KpA language consultants (see Appendix M.7) from the words in Table 4.15.

Table 4.15: Words to Elicit /a/

No	Words	Gloss	Ach	KpA
1	*ad**a**k/d**a**k*	if	✓	✓
2	*ad**a**t*	custom		✓
3	*ag**a**k*	rather	✓	
4	*(aneuk) angk**a**t*	adopted (child)		✓
5	*as**a**p*	smoke, fog	✓	
6	*bab**a**h*	mouth	✓	
7	*B**a**t*	name (of female)	✓	
8	*b**a**h*	let it, allow	✓	✓
9	*B**a**htiar*	name (of male)	✓	
10	*b**a**k*	at, on, tree	✓	✓
11	*B**a**kri*	name (of male)	✓	✓
12	*bag**a**h*	quick, fast	✓	✓

‘Table 4.15, continued’

13	*bapak/pak*	father, Mr.	✓	✓
14	*basah*	wet	✓	
15	*bècak*	rickshaw	✓	✓
16	*beukah*	rip, broken, mark	✓	✓
17	*beuleukat*	sticky rice		✓
18	*beuranggapat*	anywhere	✓	
19	*beurangkat*	leave	✓	✓
20	*beurkat*	blessing, courtesy	✓	
21	*cètak*	print		✓
22	*ceudah*	beautiful		✓
23	*dak duk*	heartbeat		✓
24	*dasat*	horrifying	✓	
25	*daster*	type of clothing	✓	
26	*dumpat*	everywhere	✓	
27	*Faizah*	name (of female)		✓
28	*Farhah*	name (of female)		✓
29	*hajat*	desire		✓
30	*Hamzah*	name (of male)		✓
31	*hak*	rights		✓
32	*hat*	at the time	✓	✓
33	*ibadah*	prayers	✓	
34	*ijasah*	certificate		✓
35	*insap*	conscious, realize	✓	✓
36	*intat/antat*	usher, escort	✓	✓
37	*jak*	go, walk	✓	✓
38	*jilbab*	head scarf	✓	
39	*kah*	you (impolite)	✓	✓
40	*Kahju*	name of village	✓	✓
41	*kak/kakak*	elder sister	✓	✓
42	*kap*	bite		✓
43	*kaptèn*	captain		✓
44	*Kedah*	name (of state)		✓
45	*ketupat*	rice dumpling		✓
46	*keurtah*	paper	✓	
47	*kisah*	story	✓	
48	*kitab*	religious book	✓	
49	*kolkah*	fridge	✓	
50	*kontak*	contact	✓	
51	*kubah/keubah*	keep, save	✓	✓
52	*lagak*	pretty	✓	
53	*lambat*	slow		✓
54	*Lamjabat*	name (of village)		✓
55	*langkah*	walk over, step	✓	✓
56	*lapak*	field	✓	
57	*lengkap*	complete	✓	

‘Table 4.15, continued’

58	*leup**a**h*	pass, took off, exceed	✓	✓
59	*malaik**a**t*	angel	✓	
60	*markis**a**h*	passion fruit	✓	
61	*mas**a**k*	ripe, cooked, well done (cooking)		✓
62	*meuh**a**t*	appropriate	✓	
63	*meuk**a**t*	sell	✓	✓
64	*meunas**a**h*	small mosque	✓	✓
65	*meuub**a**t*	medical treatment	✓	
66	*munt**a**h*	vomit	✓	
67	*musib**a**h*	disaster	✓	
68	*Nafis**a**h*	name (of female)		✓
69	*nik**a**h*	marriage	✓	
70	*pag**a**p*	stop		✓
71	*p**a**h*	fit, suitable, precisely	✓	✓
72	*pak**a**t*	invite, persuade, negotiate	✓	✓
73	*p**a**ksa*	force	✓	✓
74	*p**a**s*	visa		✓
75	*p**a**spot*	passport		✓
76	*p**a**srah*	surrender	✓	
77	*p**a**sti*	confirm	✓	
78	*p**a**t*	where	✓	✓
79	*pat**a**h*	break	✓	✓
80	*pèt**a**k*	square	✓	
81	*peug**a**h*	say	✓	✓
82	*ph**a**k*	destroyed	✓	
83	*pis**a**h*	separate	✓	
84	*prat**a**h*	bed	✓	
85	*puc**a**t*	pale	✓	
86	*rap**a**t*	close by, near		✓
87	*ret**a**k*	fissure	✓	
88	*rub**a**h*	fall	✓	
89	*rus**a**k*	broken	✓	
90	*S**a**btu*	Saturday		✓
91	*sahab**a**t*	good friend	✓	
92	*s**a**k*	insert	✓	✓
93	*sap**a**t*	together, gather	✓	✓
94	*seb**a**b*	because	✓	✓
95	*sedek**a**h*	charity	✓	✓
96	*sèh**a**t*	healthy	✓	✓
97	*sejad**a**h*	prayer mat		✓
98	*sek**a**t*	limit, border		✓
99	*semb**a**h*	worship	✓	
100	*semp**a**t*	had a chance, opportunity	✓	

‘Table 4.15, continued’

101	*sertifik**at***	certificate	✓	
102	*ses**ak***	crowded	✓	
103	*sump**ah***	swear		✓
104	*sus**ah***	worry, difficult	✓	✓
105	*t**a**fsir*	interpretation of the Qur'an	✓	
106	*tahlil*	prayer		
107	*t**ah**/t**as***	bag	✓	✓
108	*tak**at***	until		✓
109	*tap**ak***	foot, land	✓	✓
110	*teuh**ah***	open	✓	
111	*teump**ah***	order		✓
112	*teump**at***	place	✓	✓
113	*teup**at***	straight	✓	
114	*teut**ap***	still	✓	✓
115	*th**at***	very	✓	✓
116	*tingk**at***	level	✓	✓
117	*tup**at***	know where	✓	✓
118	*ub**ah***	change	✓	
119	*ub**at***	medicine	✓	✓
120	*Ulf**ah**/F**ah***	name (of female)		✓
121	*ust**ad***	religious teacher		✓
Total number of words			89	74
Total number of words			1164	827

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [a] is 880 Hz and KpA [a] is 860 Hz, and the average value of F2 for Ach [a] is 1854 Hz and KpA [a] is 1875 Hz. T-tests showed a significant difference in the F1 average values (t(1989)=4.78, p<.0001), thus, no significant difference in the F2 average values (t(1989)=3, p=0.001). The overlapping distribution of Ach [a] and KpA [a] in Figure 4.52, however, suggests that they were produced similarly.

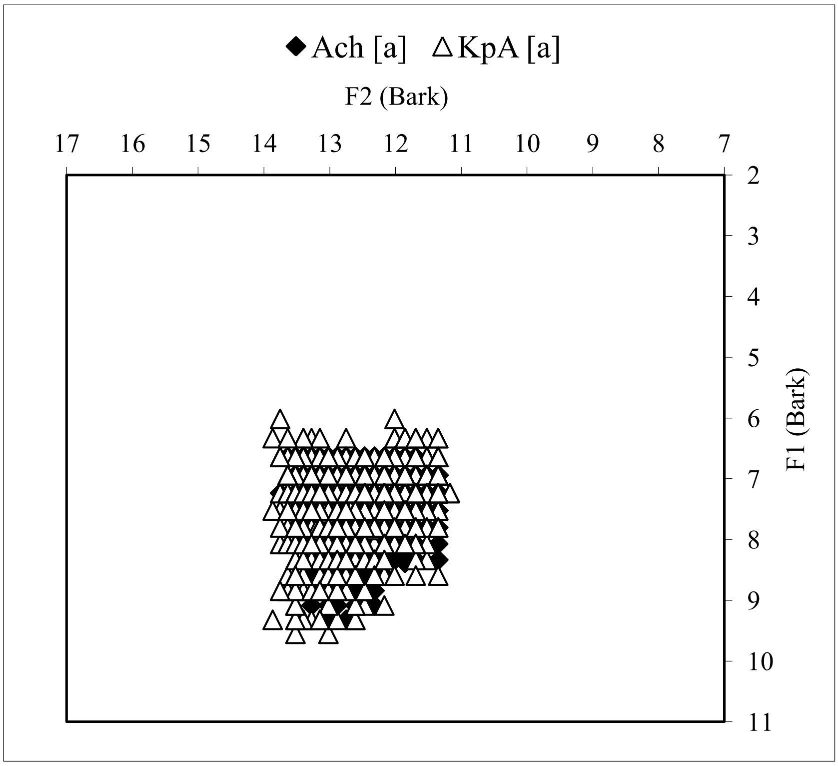


Figure 4.52: Distribution of Ach [a] and KpA [a] from INT

Moreover, Figure 4.53 shows the distribution of Ach [a] from WE and INT and it displays that they are overlapping. T-tests conducted between the two speaking contexts showed no significant differences in the F1 and F2 average values (F1; t(1192)=0.16, p=0.437; F2: t(1192)=1.02, p=0.154), indicating that they were produced similarly.

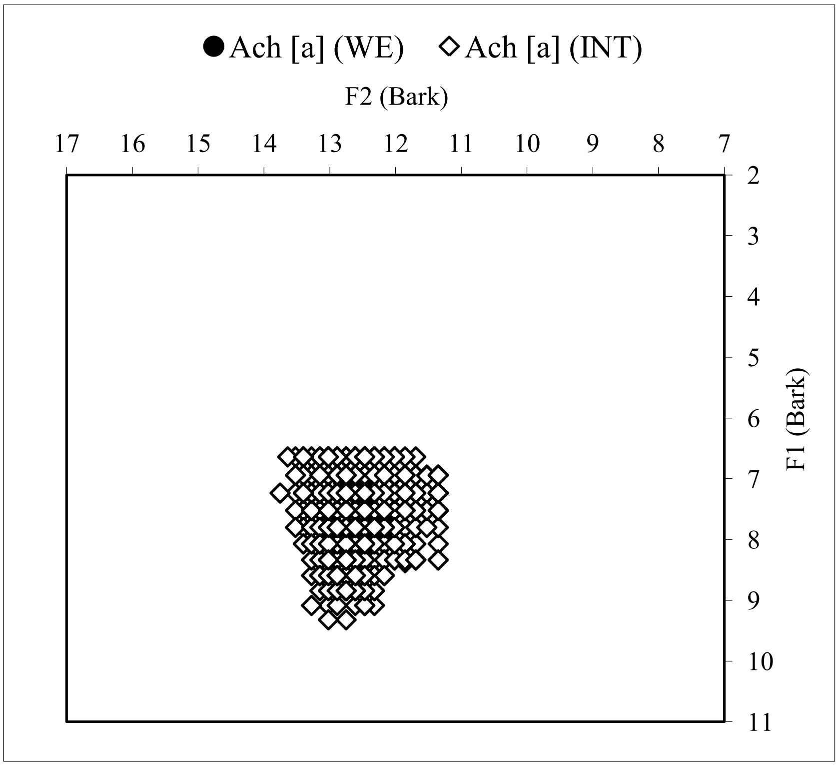


Figure 4.53: Distributions of Ach [a] from WE and INT

As for KpA [a], albeit the tokens of this sound from both speaking contexts are seen overlapping in Figure 4.54, t-tests between them indicated a significant difference in the F1 average values ($t(855)=3.93$, $p<.0001$), but no significant difference in the F2 average values ($t(855)=3.46$, $p=0.000$). This implies that KpA [a] from WE was produced higher than that from INT.

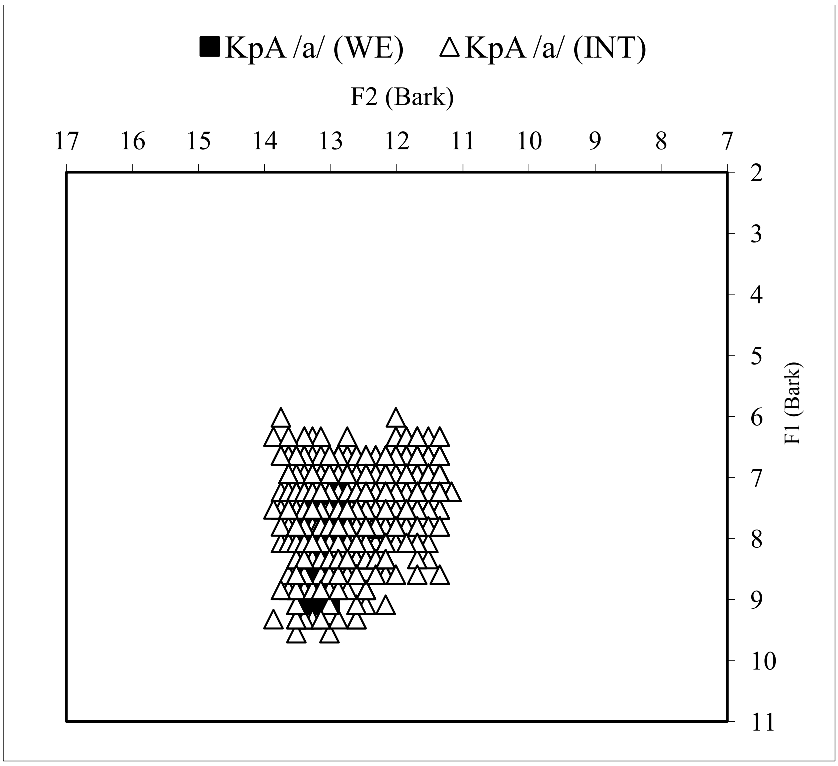


Figure 4.54: Distributions of KpA [a] from WE and INT

(b) The production of /ɑ/ by KpA language consultants

From INT, an additional sound by KpA language consultants in the CVC word context was discovered, which was the back /ɑ/ (see Appendix M.8), and this was not obtained in WE. The F1 average value for [ɑ] is 770 Hz and the F2 average value is 1436 Hz. A number of 90 tokens of [ɑ] were measured from the words in Table 4.16. The far right columns also provide the number of tokens of [ɑ] and [a] produced by KpA language consultants to illustrate that even though most of these words were pronounced with [a], thus, [ɑ] (about 10.88%) was starting to emerge in their Acehnese as every KpA language consultant had produced this sound in INT. The distribution of KpA [a] and [ɑ] can be seen in Figure 4.55.

Table 4.16: Words to Elicit [ɑ]

No	Words	Gloss	/ɑ/	/a/
1	_ab**ah**_*	father	3	0
2	_bag**ah**_	quick, fast	1	7
3	_bap**ak**_	father	7	10
4	_b**a**k_	at, on, tree	29	39
5	_j**a**k_	go	14	265
6	_k**a**k/kak**a**k_	elder sister	9	61
7	_keub**ah**_	keep, save	7	1
8	_leup**ah**_	pass, took off, exceed	2	7
9	_mas**ak**_	ripe, cooked, well done (cooking)	1	2
10	_Mek**ah**_*	name (of city, Mecca)	1	0
11	_meunas**ah**_	small mosque	1	2
12	_peug**ah**_	say	5	85
13	_reup**ah**_*	rush, scrambling	1	0
14	_sus**ah**_	worry	1	2
15	_teump**ah**_	order	1	1
16	_Ulfah/F**a**h_	name (of female)	7	10
Total number of tokens			90	489

n.b. *only produced with [ɑ].

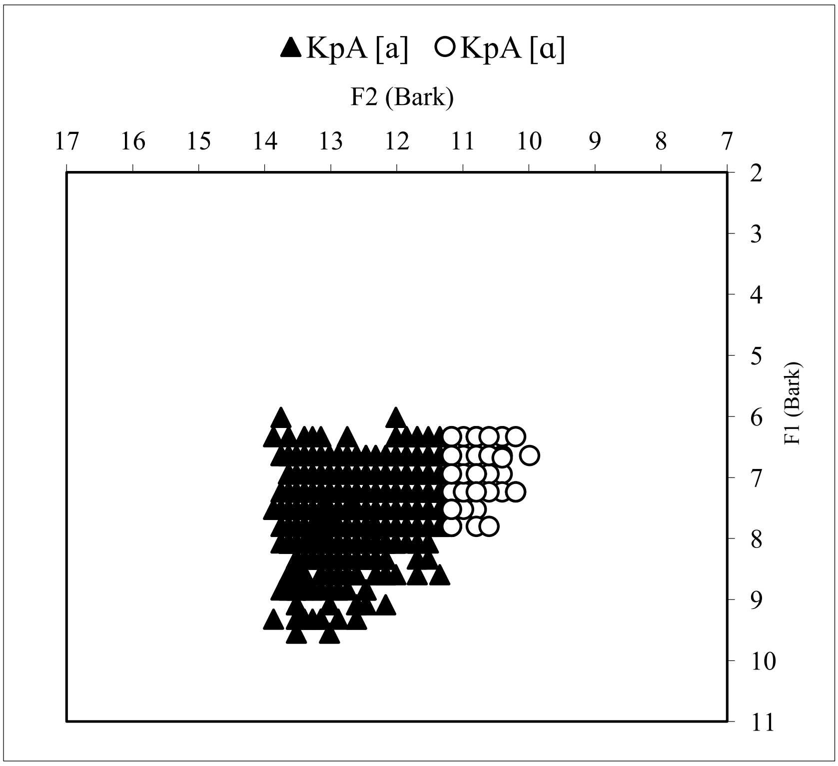


Figure 4.55: Distribution of KpA [a] and [ɑ] from INT

From the words in Table 4.16, all words produced with [ɑ] were also produced with [a], except for the words: *abah*, *Mekah* and *reupah*. Most [ɑ] was found to occur in the words *bak* and *jak*, respectively. The general patterns of occurrence for the prevailing [ɑ] by KpA language consultants based on the data in this study are as follows:

Occurrence 3: [ɑ] may emerge in the position of CVC that:

- starts with /p/ and /b/ and ends with /h/, for example from data:

  *leu**pah*** and *a**bah***
- starts with /k/ and /g/ and ends with /h/, for example from data:

  *keu**bah*** and *ba**gah***
- starts with /f/ and ends with /h/, for example from data:

  *Ul**fah***

Occurrence 4: [ɑ] may emerge in the position of CVC that:

- starts with /b/ and ends with /k/, for example from data: ***bak***
- starts with /k/ and ends with /k/, for example from data: ***kak***
- starts with /s/ and ends with /k/, for example from data: *ma**sak***
- starts with /ʤ/ and ends with /k/, for example from data: ***jak***

Furthermore, based on the examples above, vowel harmony was noted among some of the examples. This is the adjustment of manner and point of articulation of a vowel that is conditioned by the other vowel in the same structure (Yunus, 1980). As the data extracted from this present study showed vowels occurring within stops or fricatives, thus, indicating the possible occurrence of /ɑ/ in CVCVC, as demonstrated below:

1. When the first vowel is [ɯ], the second vowel may be [ɑ] for the closed syllable, such as in ***leupah*** [lɯpɑh], ***keubah*** [kɯbɑh], and ***reupah*** [rɯpɑh].
2. When the first vowel is [a], the second vowel may be [ɑ] for the closed syllable, such as in *m**a**s**a**k* [masɑk] and *b**a**g**a**h* [bagɑh].

Other structures found were VCCVC for *Ulfah* and VCVC for *abah*. However, as the data was extremely limited, not much can be further assumed for these structures.

4.3.3.8 The production of /u/

From INT, a number of 132 tokens of Ach [u] (see Appendix L.8) and 71 tokens of KpA [u] (see Appendix M.9) were measured from the words in Table 4.17.

Table 4.17: Words to Elicit /u/

No	Words	Gloss	Ach	KpA
1	*ba**cut***	little, small amount	✓	✓
2	*ben**tuk***	form		✓
3	***buk**/i**buk***	Mrs., lady	✓	
4	*Blang **Cut***	name (of village)		✓
5	***cut***	little, title for woman of noble descent	✓	✓
6	*dak **duk***	heartbeat		✓
7	***dup**/ pa**dup***	amount/how much (?)	✓	✓
8	*Has**buh***	name (male)	✓	
9	*Krueng **Cut***	name (of village)	✓	
10	*kru**puk***	chips		✓
11	***kuh***	myself (impolite)		✓
12	*ku**kut***	slice		✓
13	*Lamb**huk***	name (of village)	✓	✓
14	*lem**but***	soft	✓	
15	*ma **cut***	young aunt		✓
16	*mak**sud** (jih)*	meaning	✓	
17	*pak **cut***	young uncle		✓

‘Table 4.17, continued’

18	*s**u**t*	take off, remove	✓	✓
19	*tahj**u**d*	night prayer	✓	
20	*Tualang C**u**t*	name (of village)		✓
21	*ud**u**h*	ouch	✓	
Total number of words			12	14
Total number of tokens			132	71

n.b. ✓ means the group of speakers produced the word.

The average value of Ach [u] is 486 Hz, while KpA [u] is 503 Hz. A t-test between them showed no significant difference in the F1 average values (t(201)=3.19, p=0.001). The average value of F2 for Ach [u] is 1181 Hz, while KpA [u] is 1290 Hz, and a t-test between them showed a significant difference in the F2 average values (t(201)=5.76, p<.0001). Thus, the scatter plot of Ach [u] and KpA [u] in the vowel space overlap, as shown in Figure 4.56. This suggests that they were produced similarly.

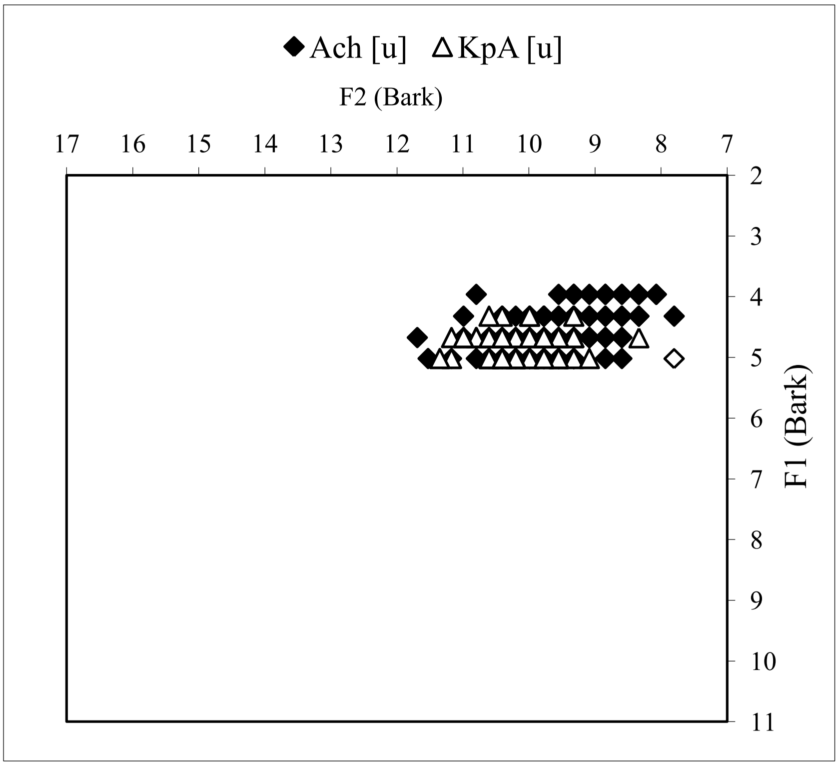


Figure 4.56: Distribution of Ach [u] and KpA [u] from INT

Additionally, the distribution of Ach [u] from WE and INT are presented in Figure 4.57. It shows that [u] from WE are more fronted than INT but similar in height. This is substantiated by t-tests that showed no significant difference in the F1 average values (t(160)=2.88, p=0.002), but a significant difference in the F2 average values (t(160)=7.03, p<.0001).

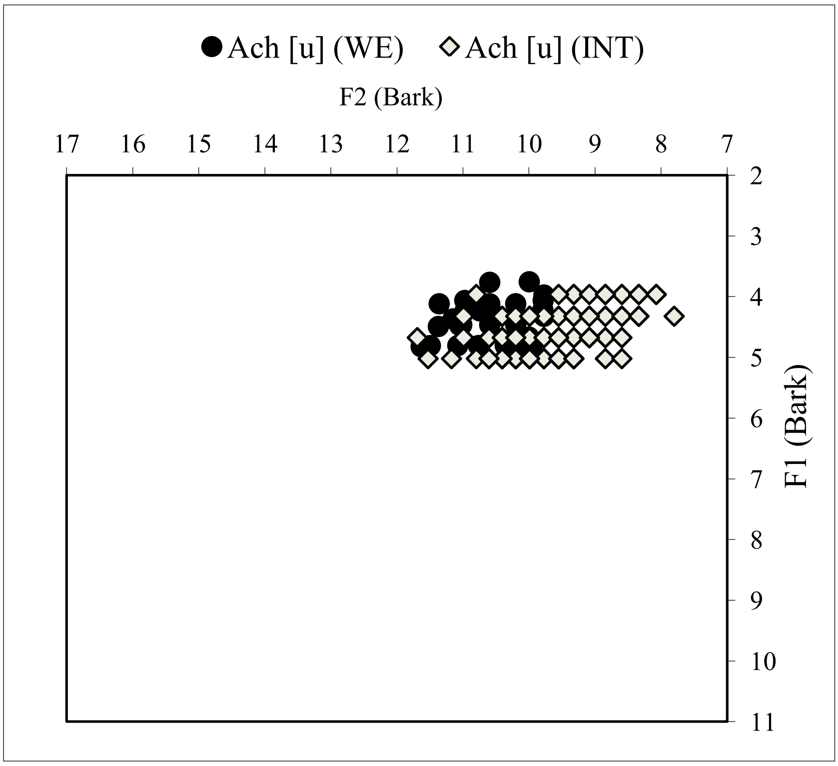


Figure 4.57: Distributions of Ach [u] from WE and INT

For KpA [u], t-tests between INT and WE indicated significant differences in the F1 and F2 average values (F1: t(99)=8.26, p<.0001; F2: t(99)=7.61, p<.0001) and this means that KpA [u] from both speaking contexts were produced differently. Figure 4.58 shows the distribution of KpA [u] from WE and INT and the tokens from WE are seen to be higher and fronted compared to INT.

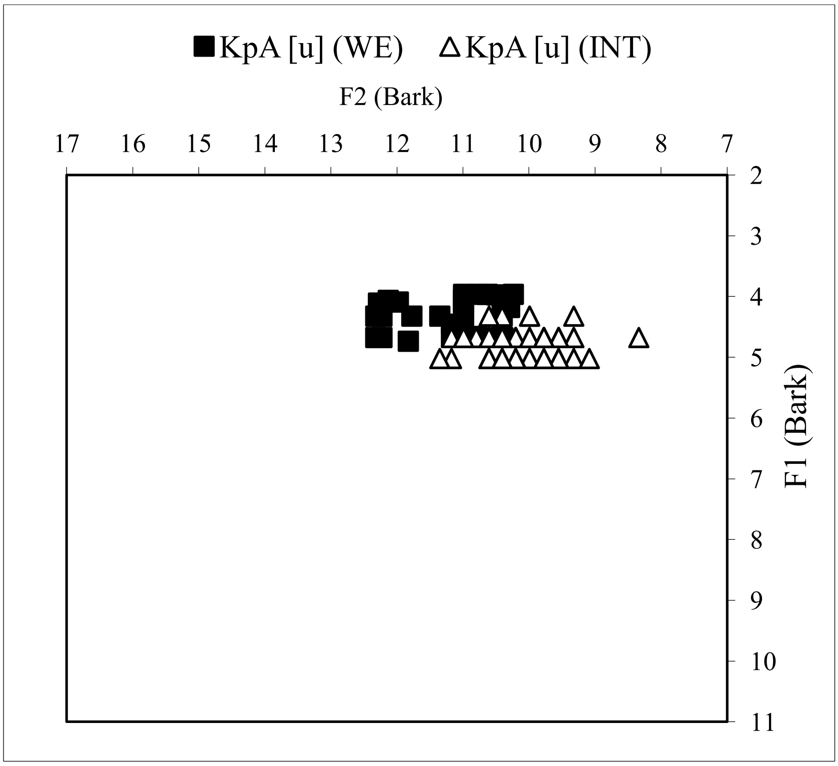


Figure 4.58: Distributions of KpA [u] from WE and INT

4.3.3.9 The production of /o/

A total of 210 tokens of Ach [o] (see Appendix L.9) and 206 tokens of KpA [o] (see Appendix M.10) were extracted from the words in Table 4.18 from INT.

Table 4.18: Words to Elicit /o/

No	Words	Gloss	Ach	KpA
1	*adôk*	stir		✓
2	*andôk*	towel		✓
3	*anggôk*	nod	✓	
4	*angkôt*	carry	✓	
5	*antôk*	bump (the head)	✓	
6	*bantôt*	fish dish		✓
7	*batôk*	cough	✓	
8	*beurtôh*	explode	✓	
9	*bôh*	fill in, insert, embellish, apply	✓	✓
10	*bôh (ka)*	particle of agreement, let it, allow	✓	
11	*bôt*	boat	✓	
12	*bungkôh*	bundle, wrap	✓	✓

‘Table 4.18, continued’

13	*cukôp*	very, extremely	✓	
14	*eungkôt*	fish	✓	✓
15	*geureupôh*	hencoop	✓	
16	*ikôt*	follow	✓	
17	*indôk*	main		✓
18	*jôk*	give, offer	✓	✓
19	*lampôh*	land		✓
20	*likôt*	back	✓	✓
21	*Limpôk*	name (of village)	✓	
22	*Lubôk*	name (of village)	✓	
23	*Meulabôh*	name (of city)	✓	✓
24	*pajôh*	eat	✓	✓
25	*pucôk*	(at the) top, tip	✓	
26	*putôh*	broken, cut off	✓	✓
27	*reubôh*	boil	✓	✓
28	*reudôk*	cloudy	✓	
29	*reutôh*	hundred	✓	✓
30	*reutôk*	flick, swag		✓
31	*runtôh*	collapse		✓
32	*sambôt*	welcome		✓
33	*sanggôp*	bear, capable	✓	
34	*seupôt*	evening, dark	✓	✓
35	*sôk*	wear	✓	✓
36	*takôt/teumakôt*	afraid	✓	✓
37	*tikôh*	mouse	✓	
38	*tôk*	grandfather		✓
39	*tôp*	cover, close	✓	✓
40	*tubôh*	body		✓
41	*tujôh*	seven	✓	✓
42	*Tungkôp*	name (of village)’	✓	
Total number of words			32	25
Total number of tokens			210	206

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [o] is 550 Hz and KpA [o] is 548 Hz, and the average value of F2 for Ach [o] is 1186 Hz and KpA [o] is 1209 Hz. T-tests indicated that there were no significant differences in the F1 and F2 average values (F1: $t(414)=0.88$, $p=0.190$; F2: $t(414)=2.07$, $p=0.020$). Looking at Figure 4.59, the distribution of Ach [o] and KpA [o] are seen to overlap, suggesting that they were produced similarly.

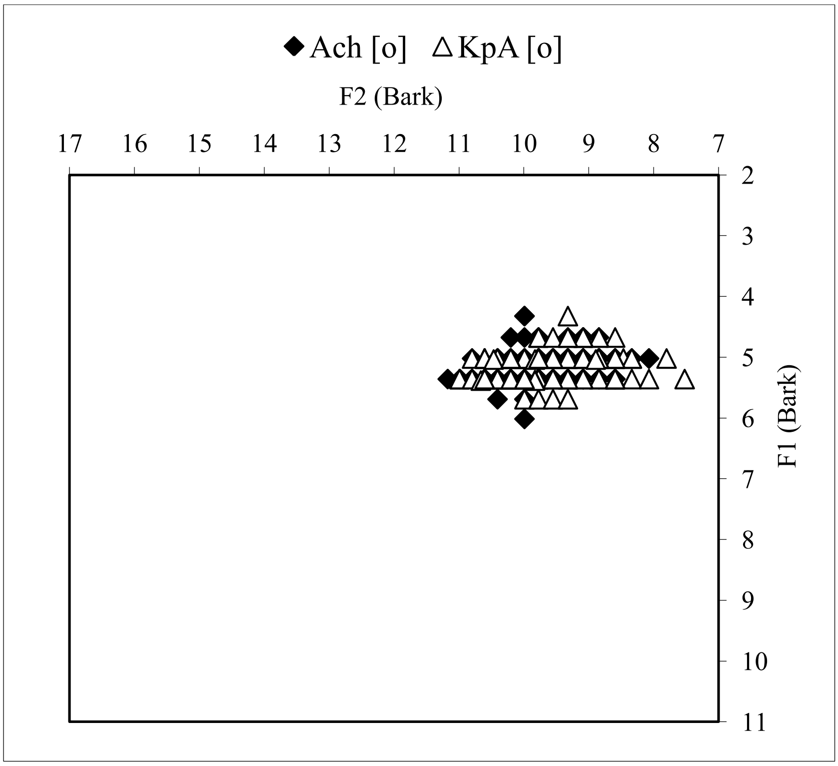


Figure 4.59: Distribution of Ach [o] and KpA [o] from INT

Furthermore, t-tests conducted between Ach [o] from WE and INT showed that there was no significant difference in the F1 average values (t(238)=3.44, p=0.000), but a significant difference in the F2 average values (t(238)=8.31, p<.0001). This suggests that Ach [o] from INT are more fronted compared to WE as represented in Figure 4.60.

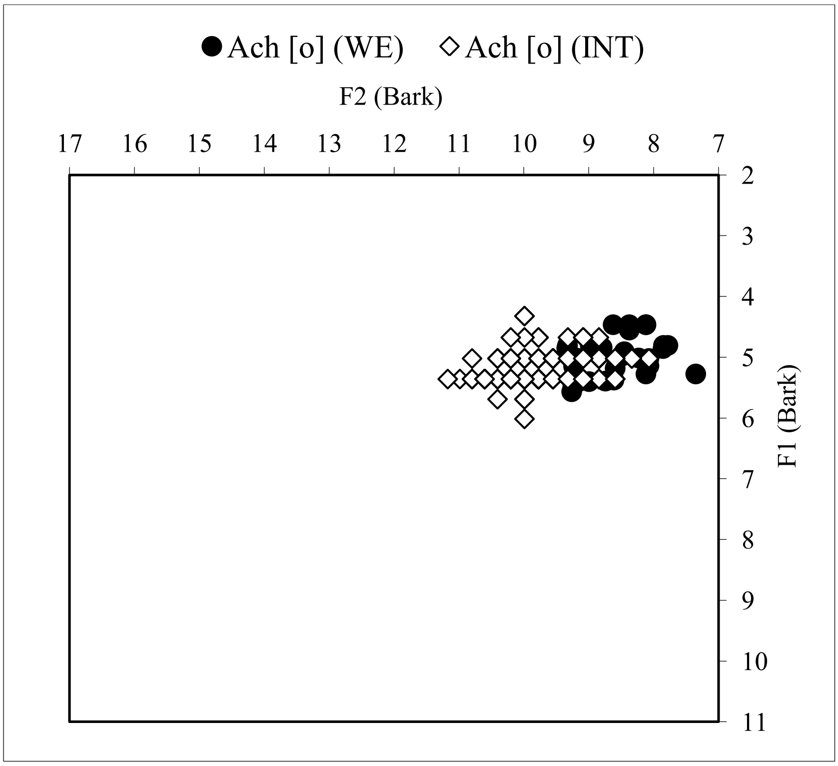


Figure 4.60: Distributions of Ach [o] from WE and INT

Additionally, t-tests between KpA [o] from WE and INT indicated significant differences in the F1 and F2 average values (F1: $t(234)=9.35$, $p<.0001$); F2: $t(234)=3.86$, $p<.0001$). This suggests that KpA [o] from both speaking contexts were produced differently. Figure 4.61 represents the distribution of KpA [o] from WE and INT and the tokens from WE are seen higher compared to INT. The tokens in INT are seen to be more spread in the vowel space.

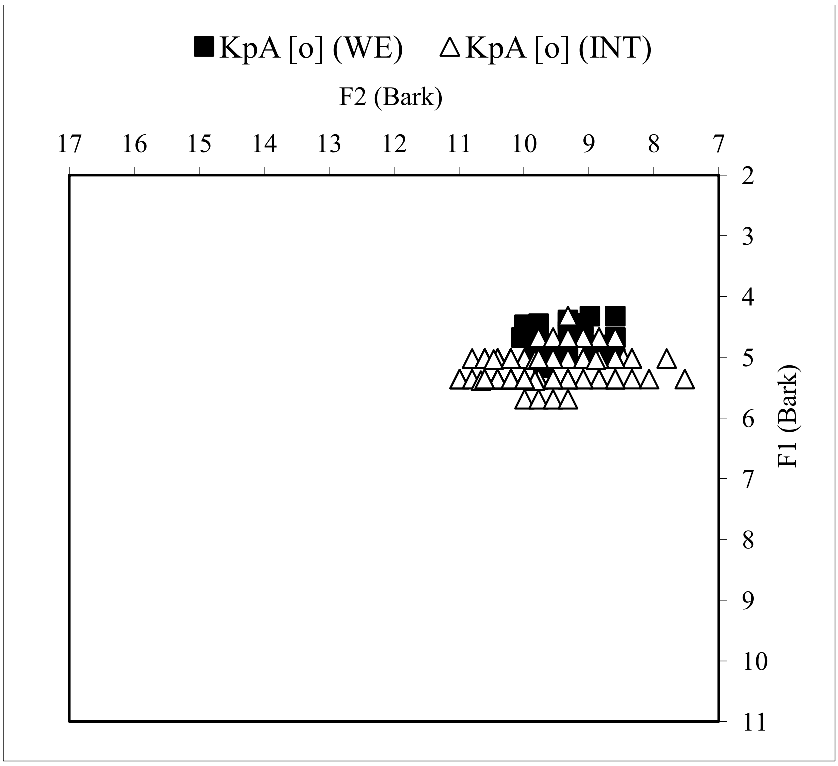


Figure 4.61: Distributions of KpA [o] from WE and INT

4.3.3.10 The production of /ɔ/

From INT, a number of 332 tokens of Ach [ɔ] (see Appendix L.10) and another 210 tokens of KpA [ɔ] (see Appendix M.11) were taken from the words in Table 4.19.

Table 4.19: Words to Elicit /ɔ/

No	Words	Gloss	Ach	KpA
1	*ad**o**psi*	adopted child	✓	
2	*b**o**h*	fruit, amount	✓	✓
3	*b**o**k*	box	✓	
4	*c**o**k*	get	✓	✓
5	*cont**o**h*	example	✓	
6	*c**o**p*	sew		✓
7	*d**o**k*	enthusiasm	✓	
8	*d**o**kto*	doctor	✓	
9	*gad**o**h*	lost, missing		✓
10	*g**o**h*	not yet	✓	
11	*g**o**p*	stranger	✓	✓

‘Table 4.19, continued’

12	*g**o**t*	ditch	✓	
13	*k**o**h*	cut	✓	✓
14	*k**o**s*	rent	✓	
15	*leuh**o**p*	mud	✓	
16	*meuleungk**o**p*	upside down	✓	
17	*meureump**o**k*	meet, found	✓	✓
18	*ph**o**k*	destroy	✓	
19	*p**o**h*	time, hit, crash, kill	✓	✓
20	*p**o**k*	clap, hit, crash	✓	✓
21	*pok**o**k (jih)*	anyway	✓	
22	*ruk**o**h*	name (of village)	✓	
23	*sab**o**h*	one	✓	✓
24	*sant**o**k*	stumble	✓	
25	*s**o**h*	empty	✓	✓
26	*songk**o**k*	head cover	✓	
27	*sub**o**h*	dawn	✓	✓
28	*tèmb**o**k*	brick wall	✓	
29	*t**o**h*	which (one)		✓
30	*t**o**p*	pound, stab		✓
31	*t**o**k*	only, just	✓	✓
32	*ungk**o**h*	payment	✓	
Total number of words			28	15
Total number of tokens			332	210

n.b. ✓ means the group of speakers produced the word.

The average value of F1 for Ach [ɔ] is 659 Hz while KpA [ɔ] is 648 Hz. The average value of F2 for Ach [ɔ] is 1289 Hz while KpA [ɔ] is 1278 Hz. T-tests between [ɔ] produced by Ach and KpA language consultants also revealed that there were no significant differences in the F1 and F2 average values (F1: $t(540)=2.55$, $p=0.006$; F2: $t(540)=5.76$, $p=0.166$). This is verified by the overlapping tokens as shown in Figure 4.62, suggesting that they were produced in a similarly manner, or showed the same vowel quality.

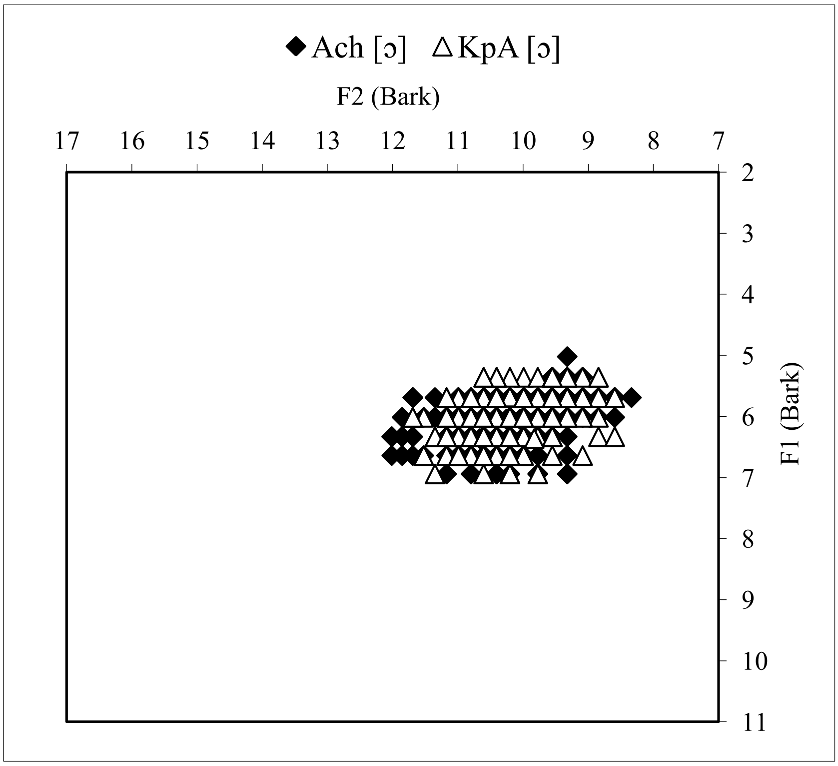


Figure 4.62: Distribution of Ach [ɔ] and KpA [ɔ] from INT

Figure 4.63 shows the scatter plot of Ach [ɔ] from WE and INT. T-tests between the two speaking contexts showed that there was no significant difference in the F1 average values ($t(360)=1.04$, $p=0.150$), however, there was a significant difference in the F2 average values ($t(360)=4.68$, $p<.0001$). The distribution of the vowels in Figure 4.63 shows that [ɔ] in WE and INT are overlapping, which suggests that they were produced similarly.

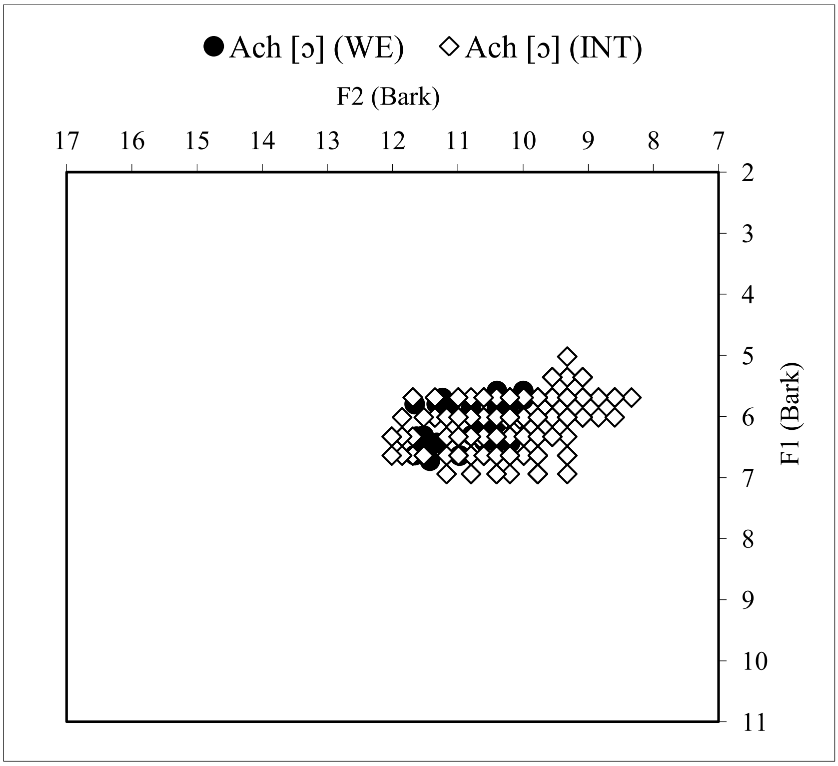


Figure 4.63: Distributions of Ach [ɔ] from WE and INT

T-tests between KpA [ɔ] from both speaking contexts showed that there was no significant difference in the F1 average values (F1: t(238)=0.02, p=0.492), but there was a significant difference in the F2 average values (t(238)=4.48, p<.0001). However, Figure 4.64 shows that the vowels produced in both contexts are overlapping, suggesting that they were produced in a similar way.

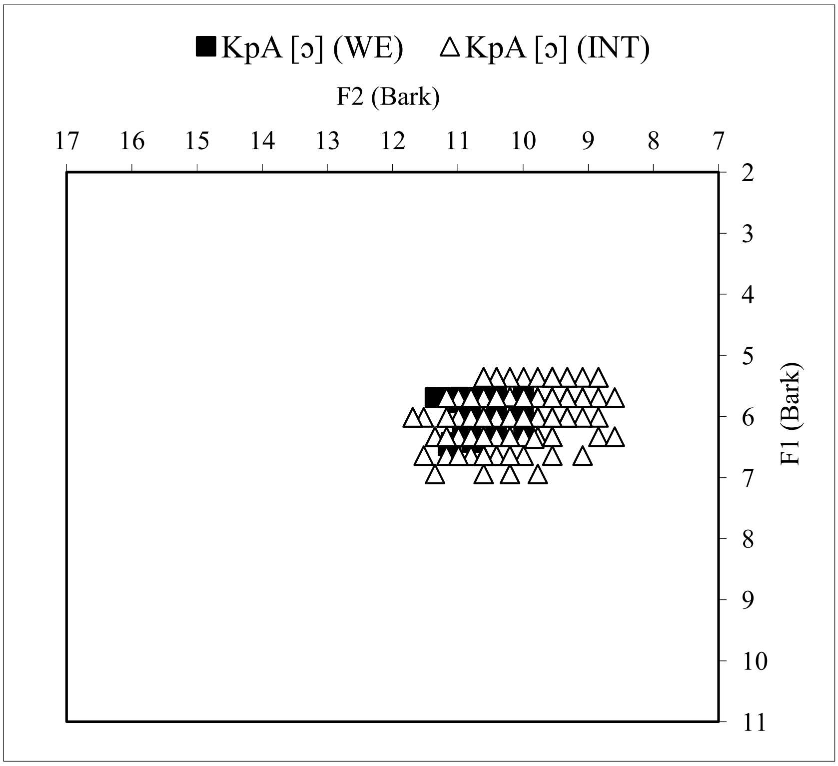


Figure 4.64: Distributions of KpA [ɔ] from WE and INT

4.4 Conclusion

The results showed that most monophthongs were generally produced similarly by Ach and KpA language consultants from both speaking contexts. These vowels were /i/, /e/, /ɛ/, /ɯ/, /a/, /u/, /o/ and /ɔ/. However, KpA language consultants had lost the realization of /ʌ/, whilst /ə/ from both contexts was described to be produced closer to [ɵ] in the vowel space. Furthermore, an additional sound [ɑ], detected in INT, was found to emerge in the speech of KpA language consultants. From INT, /ʌ/ was also realized as [ɛ] or [ɔ] by these language consultants, depending on the word environment.

Subsequently, Figure 4.65 and Figure 4.66 illustrate the F1 and F2 correspondence to vowel height and retraction of each monophthong produced by both groups of language consultants from WE. T-tests results showed no significant differences in the F1 correspondence (t(9)=1.55, p=0.078) and in the F2 correspondence (t(9)=1.79, p=0.054). This indicates that the height and retraction of each monophthong produced by both groups of language consultants from WE were similar.

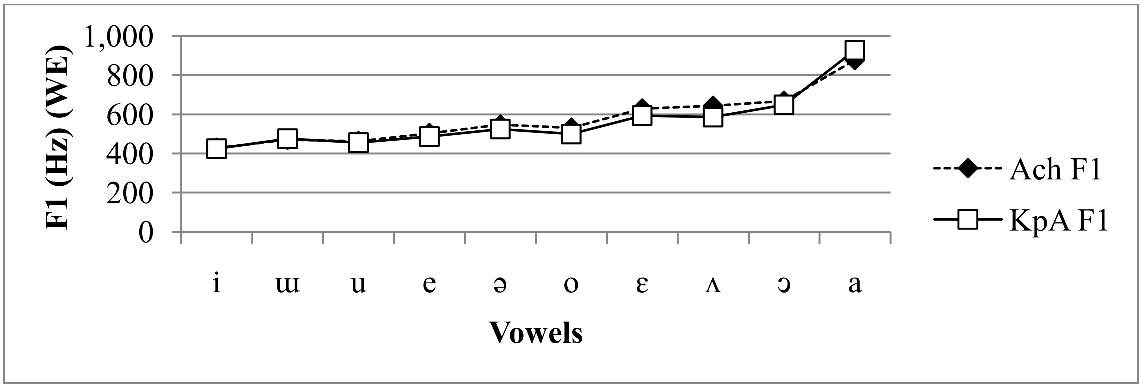


Figure 4.65: Correspondence of F1 in Ach and KpA monophthongs

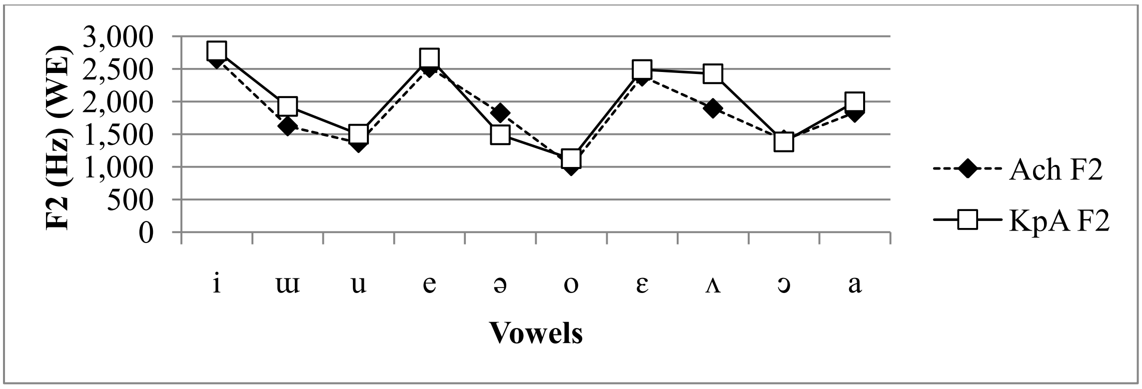


Figure 4.66: Correspondence of F2 in Ach and KpA monophthongs

Figure 4.67 and Figure 4.68 further illustrate the F1 and F2 correspondence to vowel height and retraction produced by both Ach and KpA language consultants for the monophthongs from INT. T-tests results showed no significant differences in the F1 correspondence (t(9)=0.29, p=0.389) and in the F2 correspondence (t(9)=0.8, p=0.222). This also indicates that the height and retraction of each monophthong produced by both groups of language consultants from INT are similar.

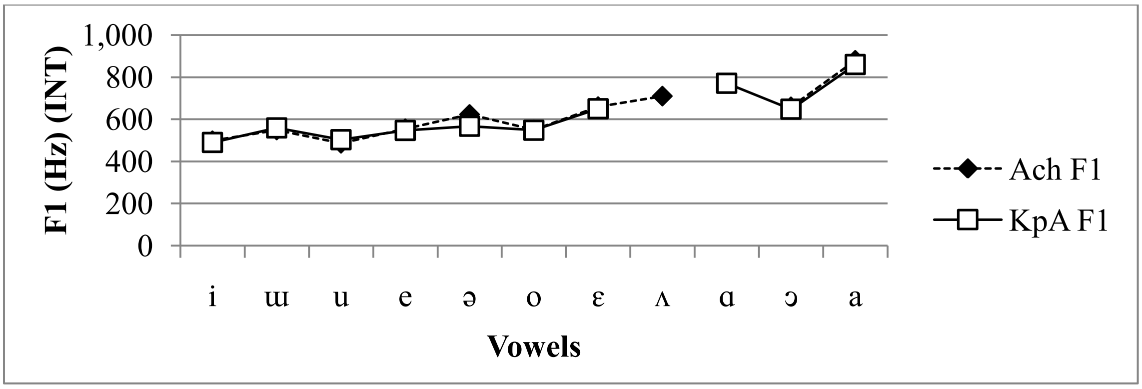


Figure 4.67: Correspondence of F1 in Ach and KpA monophthongs

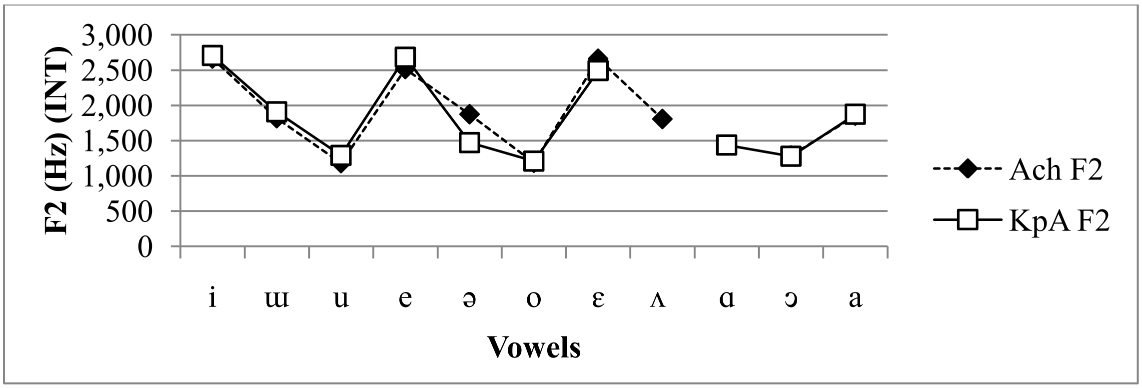


Figure 4.68: Correspondence of F2 in Ach and KpA monophthongs

CHAPTER 5 : FINDINGS FROM DIPHTHONGS

5.1 Introduction

This chapter presents the findings from WE and INT for the oral diphthongs. Statistical analysis was also performed using independent sample t-tests to compare and determine whether the quality of each vowel was produced similarly or differently by Ach and KpA language consultants. To study the qualities of the vowels in different contexts, comparisons were also conducted between the findings from WE and INT.

5.2 Diphthongs from WE

As discussed in 2.3.1.2, there are two groups of Acehnese diphthongs (Asyik 1987); those that end with /ə/ (centering diphthongs) and those that end with /i/ (rising diphthongs). The centering diphthongs are /iə/, /ɯə/, /uə/, /ɛə/, /ʌə/ and /ɔə/, and the rising diphthongs are /ui/, /əi/, /oi/, /ʌi/, /ɔi/ and /ai/. For the measurement of these diphthongs from WE by both Ach and KpA language consultants, a total of 717 elicitation tokens were selected.

Every language consultant from each group repeated 12 of the target words 3 times each, making 36 tokens for every vowel by every language consultant. One language consultant, KpA3, mispronounced *hei* 'to call' with /əi/ as [ai], therefore, the three tokens to collect this sound from this speaker was excluded, therefore, only 357 tokens in total were selected for KpA language consultants. As for Ach language consultants, 12 vowels x 10 language consultants x 3 repetitions presented a total of 360 tokens. These tokens were calculated for their ROC values for both F1 and F2 at the beginning and ending of each diphthong. The list and measurements for the diphthongs in Hertz and Bark from WE are provided in Appendix N for Ach language consultants and Appendix O for KpA language consultants.

The findings from Ach and KpA diphthongs are discussed comprehensively in the following sections. In the following figures, the two ends of the arrow that represents the onset and offset of a diphthong show the trajectories of diphthongs in the vowel space.

5.2.1 Ach Diphthongs from WE

For Ach language consultants, there were 360 tokens measured in total, with 180 tokens for centering diphthongs and another 180 tokens for rising diphthongs.

5.2.1.1 Ach Centering Diphthongs from WE

Table 5.1 presents the F1 and F2 ROC average values for each centering diphthong by Ach language consultants from WE and SD are in parentheses.

Table 5.1: F1 and F2 ROC Average Values, and SD for Ach Centering Diphthongs

Diphthongs	Target Word	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
iə	*tiep*	483 (577)	-6456 (3126)
ɯə	*beuet*	689 (698)	3493 (2053)
uə	*buet*	882 (705)	4123 (1791)
ɛə	*kèe*	131 (450)	-616 (786)
ʌə	*dhöe*	-1026 (537)	-2330 (1720)
ɔə	*toe*	-690 (802)	-1001 (1124)

Based on Table 5.1, the F1 and F2 ROC average values for [ɛə] are small, indicating little movement from the onset to offset of this vowel. This is confirmed by the small movement for this diphthong captured in Figure 5.1. The positive F1 ROC average values of [iə], [ɯə] and [uə] indicate lowering trajectories, while the negative F1 ROC average values of [ʌə] and [ɔə] indicate rising trajectories that are discernible in Figure 5.1. The negative F2 ROC average values mean that the vowel is moving towards the back of the vowel space. As shown in Figure 5.1, this is indeed the case for /ʌə/ and /ɔə/, where these diphthongs are seen to move to high back positions approximating /u/ and realized closer to [ʌu] and [ɔu]. For Figure 5.1, every centering diphthong average measurement in Bark for Ach language consultants from WE is provided in Appendices N.1.1 to N.6.2.

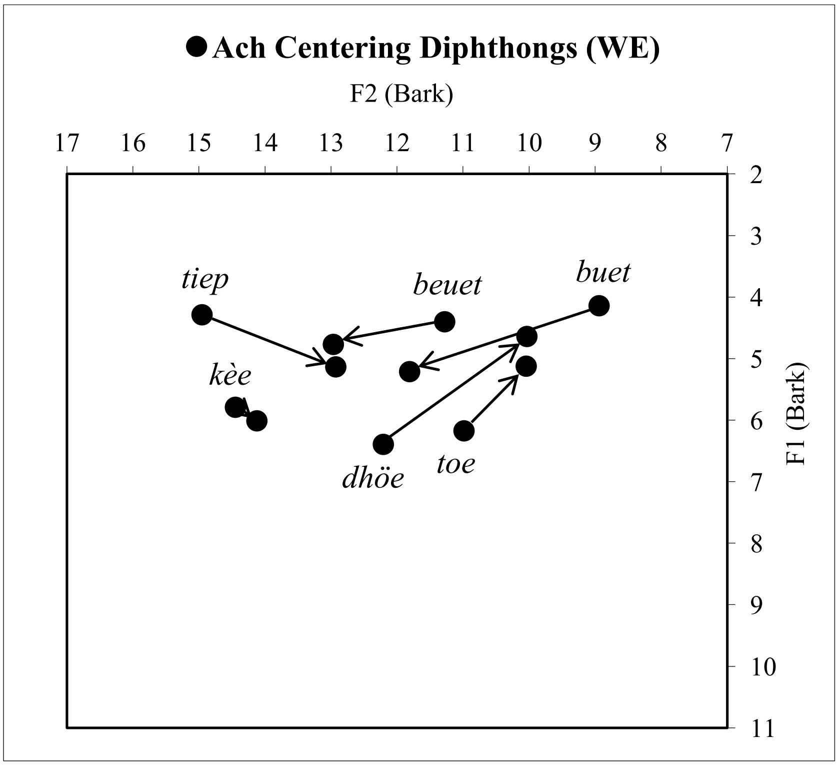


Figure 5.1: Diphthongal movements for Ach centering diphthongs from WE

5.2.1.2 Ach Rising Diphthongs from WE

Table 5.2 presents the F1 and F2 ROC average values for each rising diphthong by Ach language consultants from WE and SD are in parentheses.

Table 5.2: F1 and F2 ROC Average Values, and SD for Ach Rising Diphthongs

Diphthongs	Target Word	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
ui	*bui*	6 (407)	6891 (2406)
əi	*hei*	-953 (476)	4360 (1207)
oi	*bhôi*	-10 (363)	5810 (2107)
ʌi	*lagöina*	-1562 (848)	7373 (2044)
ɔi	*poih*	-1302 (1217)	5188 (3276)
ai	*jai*	-1643 (927)	2985 (924)

Table 5.2 shows that the larger F1 ROC average value for Ach [ai] indicates greater formant movement in vowel height compared to other diphthongs. While the smaller F1 ROC average values for [ui] and [oi] indicate a lack of change in vowel height for these diphthongs. However, the F2 ROC average values for all vowels mirror the back to front trajectories of these diphthongs as presented in Figure 5.2. The trajectories for all diphthongs, as indicated by the positive F2 ROC values in Table 5.2, are reflected in Figure 5.2. However, the diphthong /ɔi/ from *poih* appears to move towards the center of the vowel space, with the language consultants realizing this diphthong closer to [ɔə]. For Figure 5.2, every rising diphthong average measurement in Bark for Ach language consultants from INT are provided in Appendices N.7.1 to N.12.2.

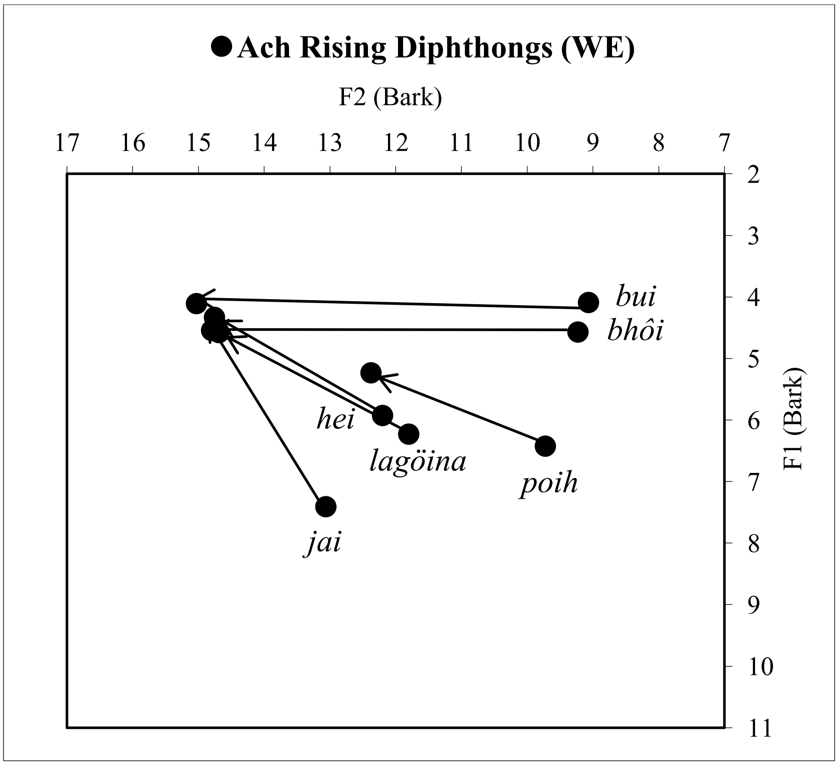


Figure 5.2: Diphthongal movements for Ach rising diphthongs from WE

5.2.2 KpA Diphthongs from WE

For KpA language consultants, there were 357 tokens measured in total, with 180 tokens for centering diphthongs, thus, only 177 tokens for rising diphthongs as three tokens were removed from the mispronunciation of *hei* by KpA3 (see 5.2).

5.2.2.1 KpA Centering Diphthongs from WE

Table 5.3 presents the F1 and F2 ROC average values for each centering diphthong by KpA language consultant from WE and SD are in parentheses.

Table 5.3: F1 and F2 ROC Average Values, and SD for KpA Centering Diphthongs

Diphthongs	Target Word	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
iə	*tiep*	-21 (237)	-1290 (2653)
ɯə	*beuet*	-223 (221)	2358 (1398)
uə	*buet*	113 (190)	4639 (3177)
ɛə	*kèe*	25 (230)	-19 (57)
ʌə	*dhöe*	-598 (281)	-1047 (480)
ɔə	*toe*	-637 (382)	-884 (857)

Based on the values in Table 5.3, for /iə/ in *tiep*, its F1 ROC average value is small. In other words, KpA language consultants produced [iə] with exceptionally little diphthongal movement. In Figure 5.3, we can see the trajectory of [iə] that implies KpA language consultants produced [iə] as [i]. The sound /ɯə/ in *beuet* was also produced with little diphthongal movement as indicated by its small F2 ROC average value, however, it trajectory does show movement to the front of the vowel space. The F2 ROC average value for /uə/ in *buet* is also small, thus, a trajectory is also seen to move to the front of the vowel space. As for /ɛə/ in *kèe*, both F1 and F2 ROC average values are exceptionally little. This indicates very little diphthongal movement of this diphthong, suggesting that [ɛə] was realized as a long monophthong [ɛː]. The negative F2 ROC average values for both /ʌə/ in *dhöe* and /ɔə/ in *toe* show trajectories towards the back of the vowel space. Both show a tendency to move towards [o], with both sounds similar to the sound of [ɔo]. T-tests between the production of [ɔo] in *dhöe* and *toe* further confirmed no significant differences (F1: $t(58)=0.45$, $p=0.327$; F2:

t(58)=0.73, p=0.234), meaning that the diphthongs in both words were produced similarly. For Figure 5.3, every centering diphthong average measurement in Bark for KpA language consultants from WE is provided in Appendices O.1.1 to O.6.2.

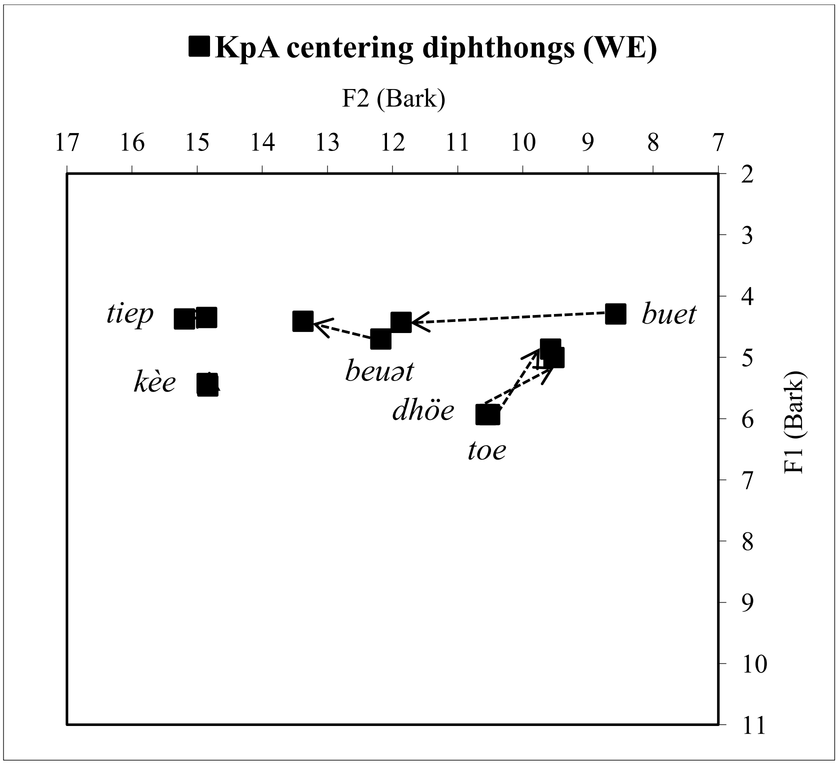


Figure 5.3: Diphthongal movements for KpA centering diphthongs from WE

5.2.2.2 KpA Rising Diphthongs from WE

Table 5.4 shows the F1 and F2 ROC average values for each diphthong rising diphthong by KpA language consultants from WE and SD are in parentheses.

Table 5.4: F1 and F2 ROC Average Values, and SD for KpA Rising Diphthongs

Diphthongs	Target Word	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
ui	*bui*	-82 (159)	7213 (1580)
əi	*hei*	-288 (179)	6986 (2439)
oi	*bhôi*	-210 (158)	6685 (1360)
ʌi	*lagöina*	-774 (332)	6711 (2527)
ɔi	*poih*	-369 (595)	8159 (3348)
ai	*jai*	-1607 (471)	2649 (871)

Table 5.4 shows that the larger F1 ROC average value for KpA [ai] indicates greater formant movement in vowel height compared to the other vowels. The small F1 ROC average values for [ui] and [oi] indicate a lack of change in vowel height for these diphthongs. However, the F2 ROC average values for all vowels mirror the back to front trajectories of these diphthongs. The trajectories for all diphthongs, as indicated by the positive F2 ROC average values in Table 5.4, are reflected in Figure 5.4. The diphthong in *hei* was realized as [oi], and this can be seen in its trajectory that starts at the high back position instead of the center. T-tests were conducted to compare the [oi] in *hei* with the one in *bhôi* and the results showed no significant differences in the F1 and F2 ROC average values (F1: $t(55)=1.94$, $p=0.029$; F2: $t(55)=1.17$, $p=0.124$), indicating that they were produced similarly. Furthermore, the trajectory for diphthong /ʌi/ in *lagöina* suggests that it was produced closer to [ɔe]. Likewise, the diphthong /ɔi/ in *poih* is also seen to be moving towards the center of the vowel space, beginning at a low back position suggesting a realization closer to [oe]. For Figure 5.4, every rising

diphthong average measurement in Bark for KpA language consultants from WE is provided in Appendices O.7.1 to O.12.2.

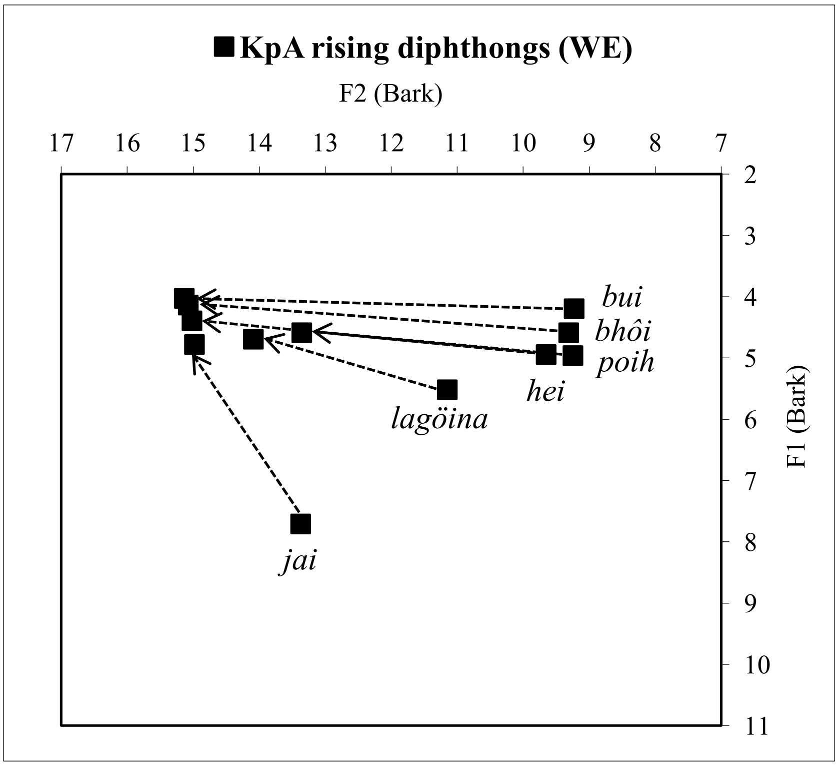


Figure 5.4: Diphthongal movements for KpA rising diphthongs from WE

5.2.3 Ach vs. KpA Diphthongs from WE

This section further elaborates the comparison of diphthong productions between Ach and KpA language consultants. Based on their ROC average values and trajectories in the vowel space, each diphthong is discussed.

5.2.3.1 The production of /iə/ in *tiep*

For /iə/ in *tiep*, both F1 and F2 ROC average values for Ach language consultants (see Appendix N.1.1 and N.1.2) are bigger than the values from KpA language consultants (see Appendix O.1.1 and O.1.2), which implies that Ach [iə] was produced with greater diphthongal movement than KpA [iə]. This is confirmed by t-tests between Ach [iə] and KpA [iə] that showed significant differences in the F1 and F2 ROC average values (F1: $t(58)=4.43$, $p<.0001$; F2: $t(58)=7.73$, $p<.0001$), suggesting that the two groups of language consultants produced /iə/ differently. Figure 5.5 shows spectrograms of *tiep* produced by Ach4 and KpA1. From KpA1, the arrow demonstrates the steady state of the vowel produced by this language consultant compared to the downward movement of F2 from Ach4.

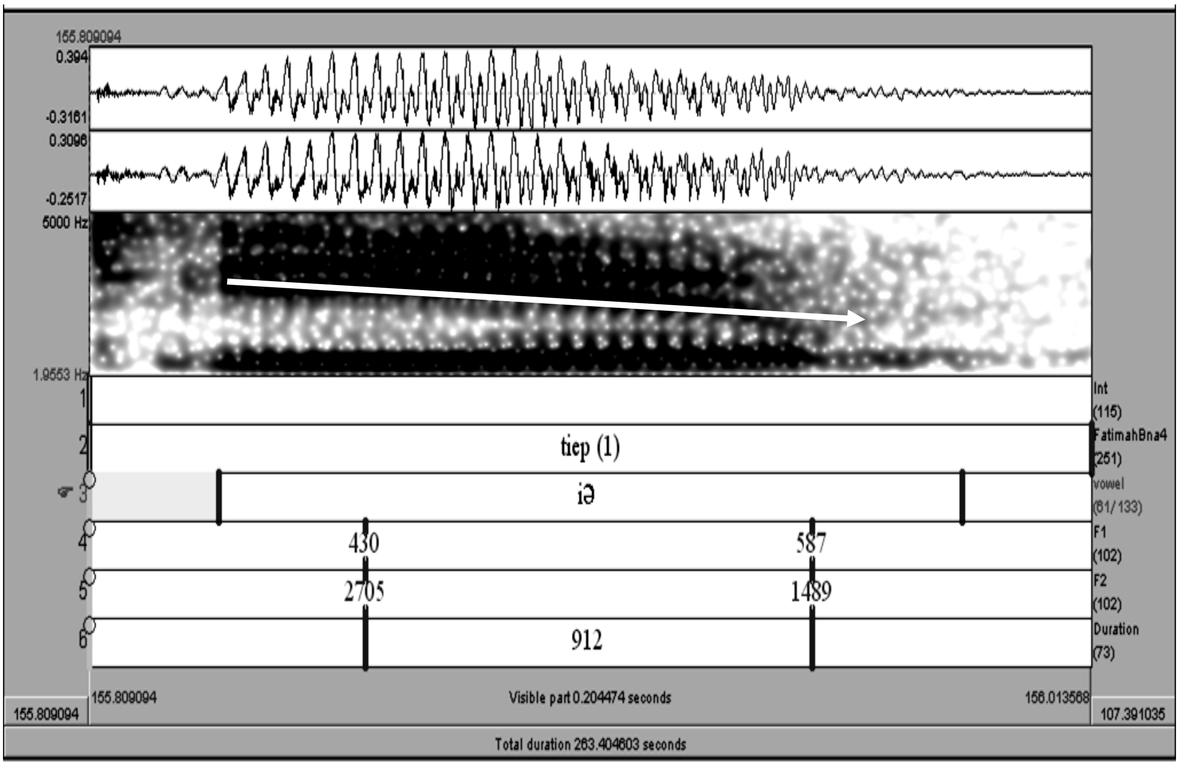


Figure 5.5: Spectrograms of *tiep* produced by Ach4

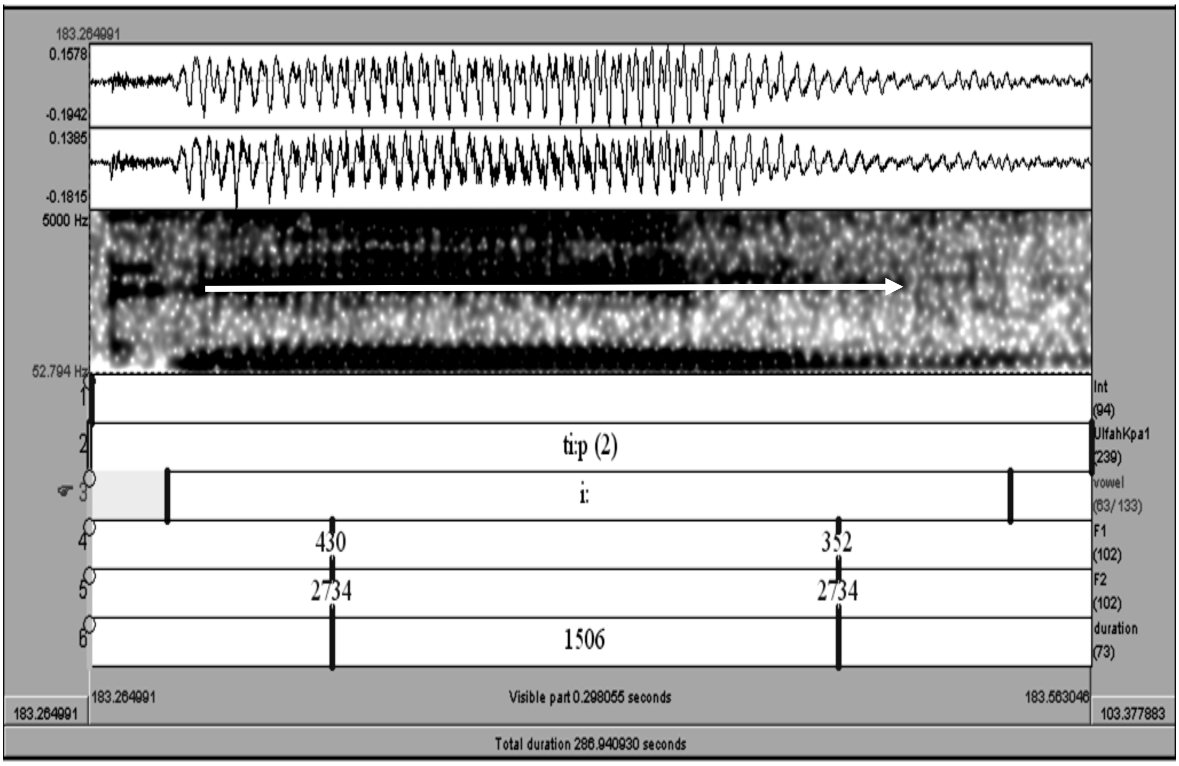


Figure 5.6: Spectrograms of *tiep* produced by KpA1

The trajectories of [iə] by Ach4 in Figure 5.5 and by KpA1 in Figure 5.6 imply that KpA1 produced this vowel as a monophthong, recognized auditorily as [i] based on its F1 and F2 average values at the beginning and ending of the vowel. No trajectory movement is also seen for KpA [iə] in Figure 5.7. Furthermore, the F1 and F2 average values of KpA [i] from *cit* are 424 Hz and 2775 Hz, whilst the F1 and F2 average values at the beginning of KpA [iə] from *tiep* are 459 Hz and 2800 Hz and at the ending are 456 Hz and 2646 Hz. Figure 5.8 shows these average values plotted in the vowel space and illustrates their close proximity distribution, which indicate similar productions. Despite that there were six tokens from the F1 and F2 ending values in Figure 5.8 that suggest diphthongal movement, thus, in general, most of them were producing this diphthong as a monophthong. This is further supported by a t-test between KpA [iə] average duration at 0.121s and KpA [i] average duration at 0.142 from WE that showed no significant difference (t(58)=2.77, p=0.004).

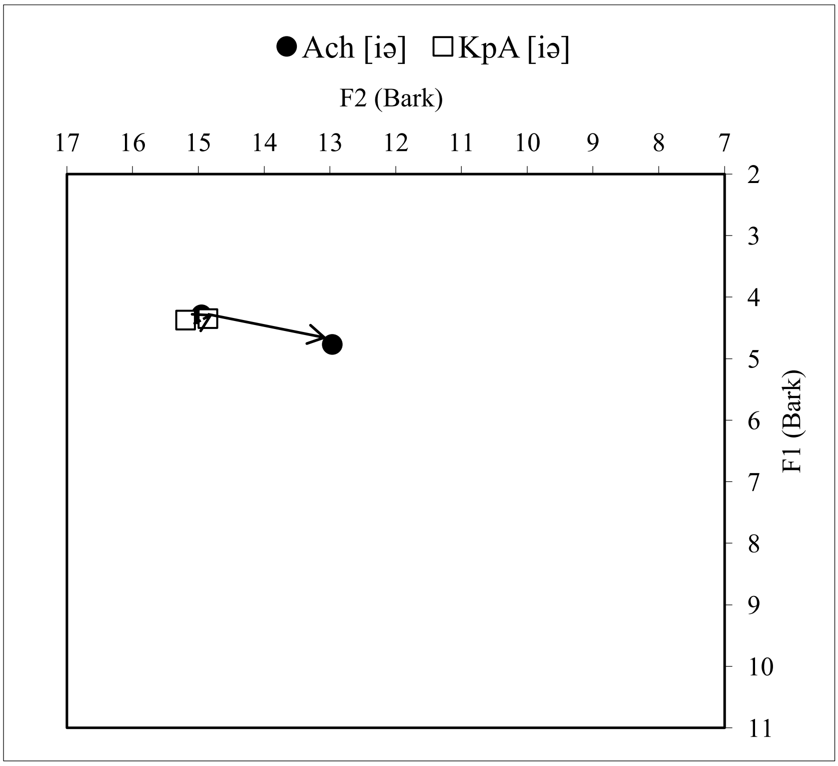


Figure 5.7: Trajectories of Ach [iə] and KpA [iə] from *tiep*
n.b. /iə/ in *tiep* is realized closer to [i] by KpA language consultants.

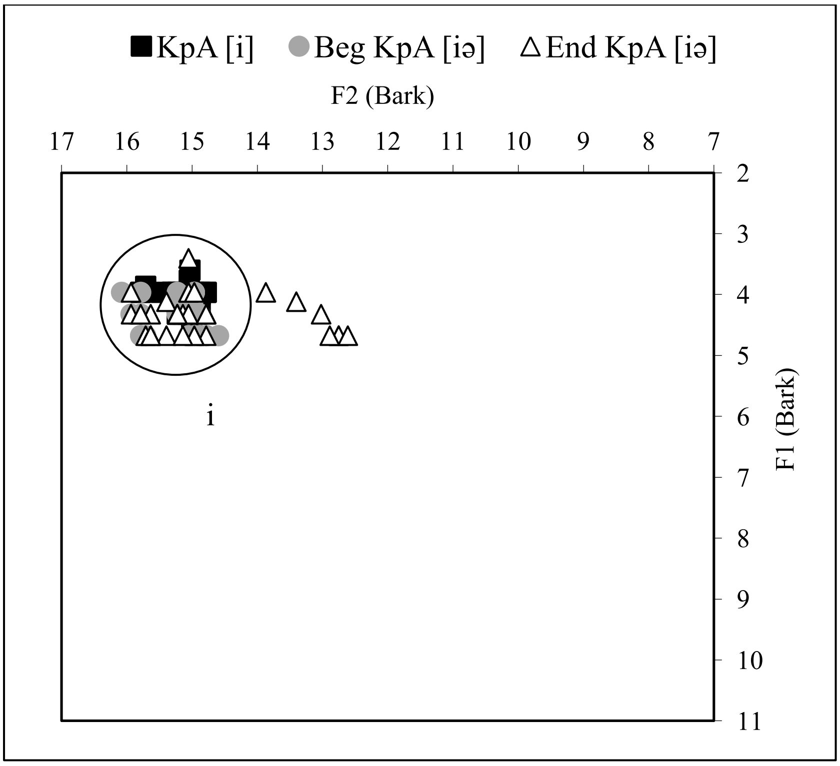


Figure 5.8: Distributions of KpA [i] and the beginning and ending of KpA [iə]
n.b. /iə/ in *tiep* is realized closer to [i] by KpA language consultants.

To clearly see the plot of Ach [i] and KpA [i] together with the trajectories of Ach [iə] and KpA [iə], Figure 5.9 shows their near productions in the vowel space.

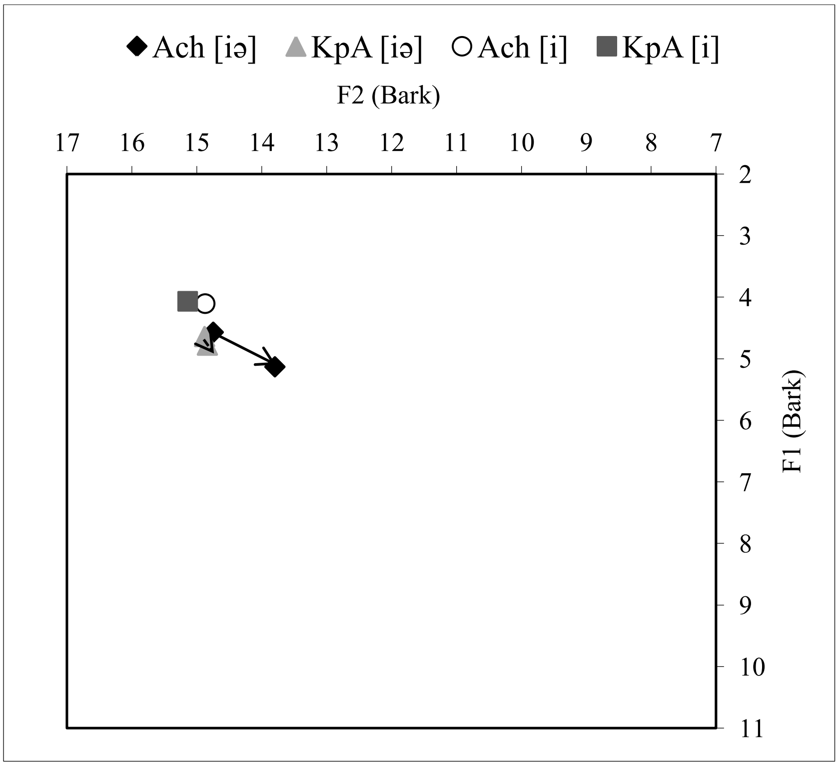


Figure 5.9: Trajectories of Ach [iə] and KpA [iə], and plot of Ach [i] and KpA [i] n.b. /iə/ in *tiep* is realized closer to [i] by KpA language consultants.

5.2.3.2 The production of /ɯə/ in *beuet*

The sound /ɯə/ in *beuet* was produced by Ach language consultants slightly more diphthongal compared to KpA language consultants and this is based on the F1 and F2 ROC average values of Ach [ɯə] (see Appendix N.2.1 and N.2.2) that are slightly larger than KpA [ɯə] (see Appendix O.2.1 and O.2.2). A significant difference was found in the F1 ROC average values ($t(58)=6.47$, $p<.0001$), and this is illustrated in Figure 5.10 where the onset of Ach [ɯə] is further back compared to KpA [ɯə]. However, there was no significant difference in the F2 ROC average values from both language consultants, (F2: $t(58)=2.93$, $p=0.002$). The trajectories of [ɯə] by both groups of language consultants in Figure 5.10 also shows that KpA language consultants produced it with lesser diphthongal movement compared to Ach language consultants. The offset of KpA [ɯə] is also seen to move towards the higher position of the vowel space instead of the center approximating [ɨ], which suggests the production of [ɯɨ].

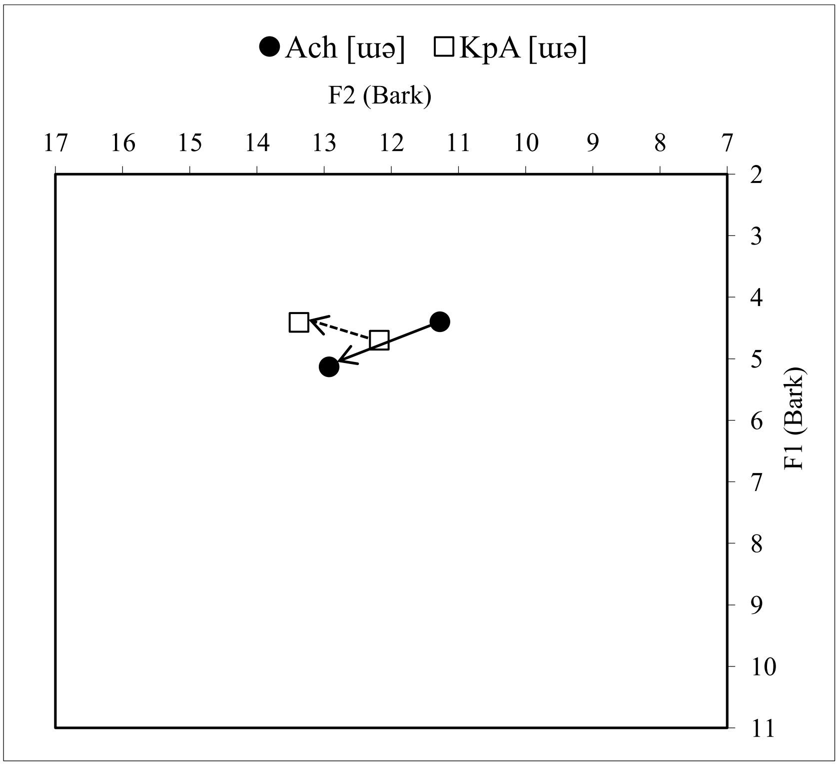


Figure 5.10: Trajectories of Ach [ɯə] and KpA [ɯə] from *beuet*
n.b. /ɯə/ in *beuet* is realized closer to [ɯɨ] by KpA language consultants.

5.2.3.3 The production of /uə/ in *buet*

The F1 and F2 ROC average values from Ach [uə] in *buet* (see Appendix N.3.1 and N.3.2) are bigger than KpA [uə] (see Appendix O.3.1 and O.3.2), which imply that Ach language consultants produced it with a more diphthongal movement than KpA language consultants. Moreover, a significant difference in the F1 ROC average values was found ($t(58)=6.05$, $p<.0001$). Figure 5.11 also illustrates that the onset of Ach [uə] is slightly further back compared to KpA [uə], but no significance difference was found in the F2 ROC average values ($t(58)=1.17$, $p=0.123$). The trajectory of this diphthong by KpA language consultants also shows that its offset is not lowering towards the center of the vowel space but still occupies the higher position, approximating [ɯ]. This suggests that they realized /uə/ closer to [uɯ].

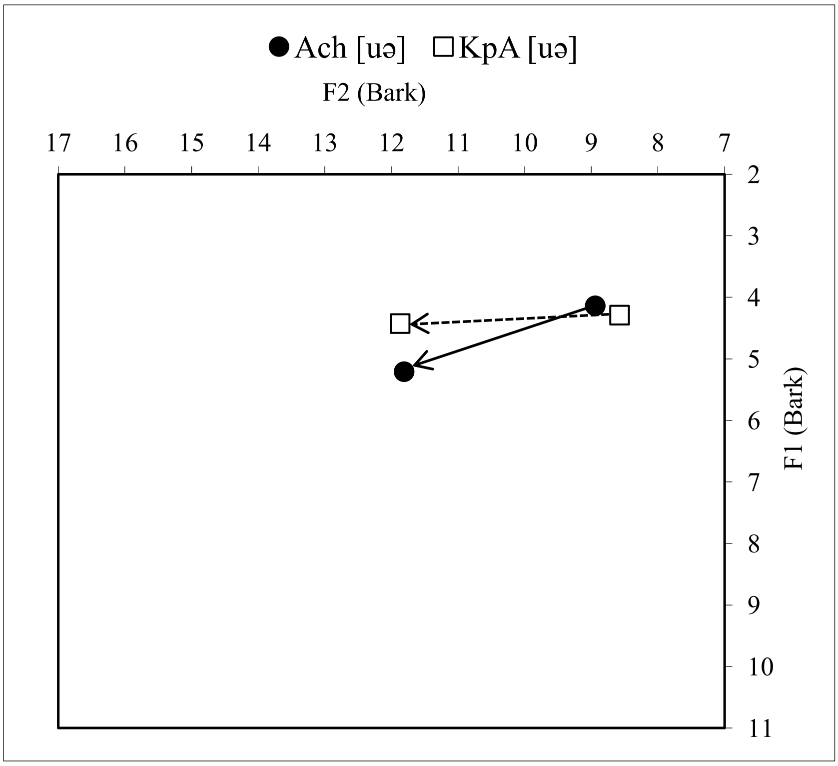


Figure 5.11: Trajectories of Ach [uə] and KpA [uə] from *buet*
n.b /uə/ in *buet* is realized closer to [uɯ] by KpA language consultants

5.2.3.4 The production of /ɛə/ in *kèe*

Although the F1 and F2 ROC average values for Ach [ɛə] in *kèe* (see Appendix N.4.1 and N.4.2) show a little more diphthongal movement than KpA [ɛə] (see Appendix O.4.1 and O.4.2), significant differences were not found in the F1 and F2 ROC average values between both language consultants (F1: t(58)=1.07, p=0.145; F2: t(58)=3.51, p=0.000). The trajectory of Ach [ɛə] in Figure 5.12 shows some diphthongal movement, but very little.

As for KpA language consultants, no movement at all is seen for its trajectory of [ɛə] in Figure 5.12. A t-test between KpA [ɛə] and KpA [ɛ] from WE for average durations could not be conducted as the samples for KpA [ɛ] was *n*<30 (see 4.2.3.3). However, Figure 5.13 shows the overlapping distribution of KpA [ɛ] with the beginning and ending of KpA [ɛə] that suggests similar realizations. The F1 and F2 average values of KpA [ɛ] from *cèt* are 580 Hz and 2214 Hz, whilst the F1 and F2 average values at the beginning of KpA [ɛə] from *kèe* are 581 Hz and 2642 Hz and at the ending are 586 Hz and 2638 Hz. Furthermore, based on the average durations, KpA [ɛə] was produced longer at 0.210s compared to KpA [ɛ] at 0.160s. T-test between KpA [ɛ] and KpA [ɛə] from WE also showed a significant difference in the average durations ($t(58)=5.02$, $p<.0001$), suggesting that KpA [ɛə] was produced as a long monophthong [ɛː].

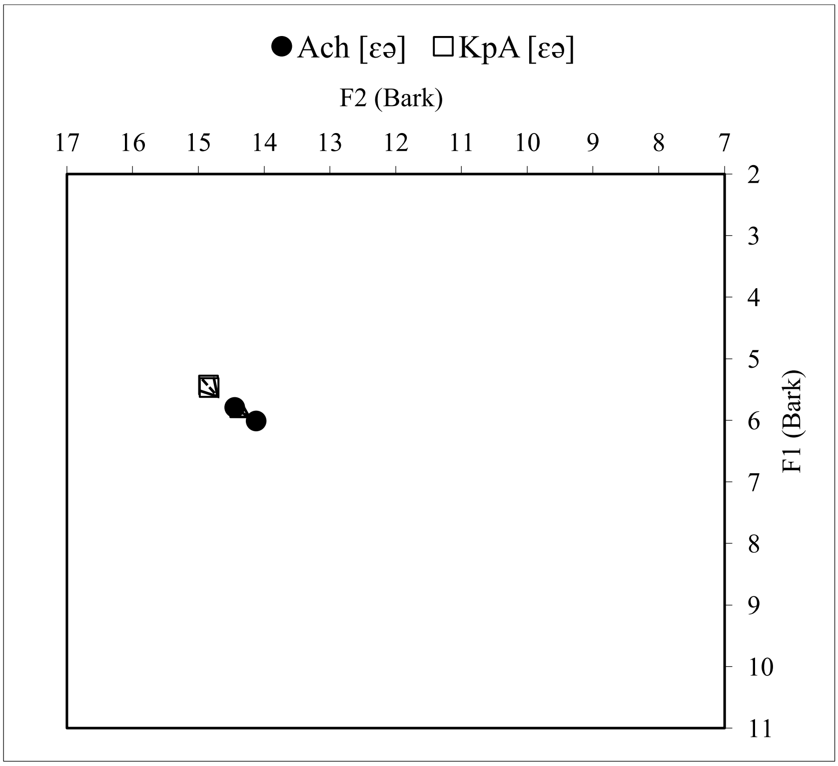


Figure 5.12: Trajectories of Ach [ɛə] and KpA [ɛə] from *kèe*
n.b. /ɛə/ from *kèe* is realized closer to [ɛː] by KpA language consultants.

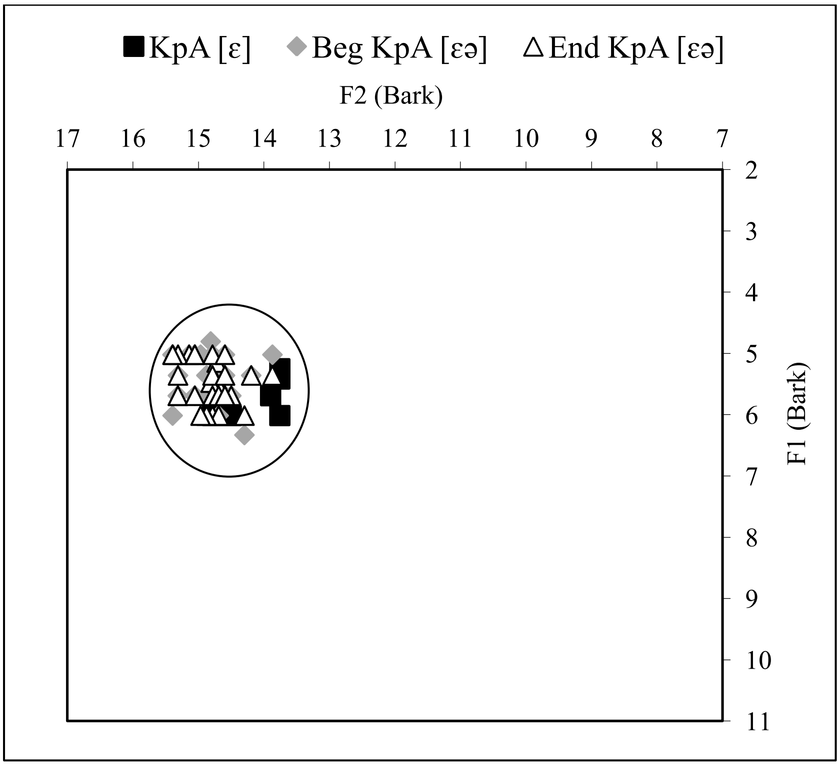


Figure 5.13: Distribution of KpA [ɛ] and the beginning and ending of KpA [ɛə]
n.b. /ɛə/ from *kèe* is realized closer to [ɛː] by KpA language consultants.

5.2.3.5 The production of /ʌə/ in *dhöe*

The sound [ʌə] in *dhöe* was produced by Ach language consultants with larger F1 and F2 ROC average values (see Appendix N.5.1 and N.5.2) and with more movement compared to KpA language consultants (see Appendix O.5.1 and O.5.2). Between both groups of language consultants, significant differences were found in the F1 and F2 ROC average values (F1: $t(58)=4.41$, $p<.0001$; F2: $t(58)=4.57$, $p<.0001$), which suggests that they produced [ʌə] differently. The F2 ROC average values for both language consultants also resulted in negative values, and this is illustrated in Figure 5.14 that shows their rising trajectories. For Ach language consultants, it moves toward a high trajectory that suggests a sound akin to [ʌu]. Whilst for KpA language consultants, it also moves toward a high trajectory, but suggests a sound closer to [ɔo].

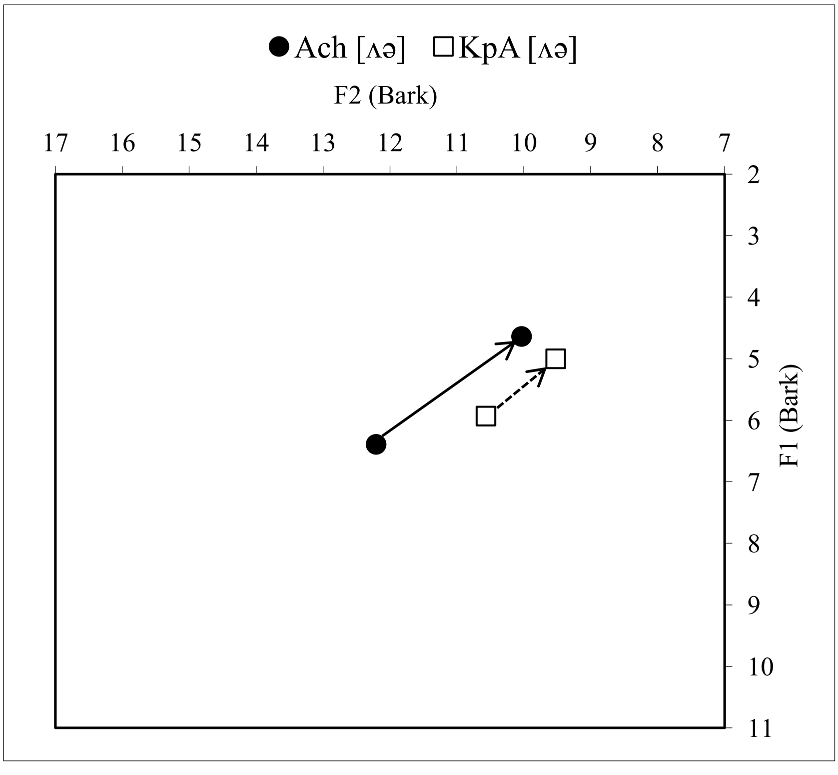


Figure 5.14: Trajectories of Ach [ʌə] and KpA [ʌə] from *dhöe*
n.b. /ʌə/ in *dhöe* is realized closer to [ʌu] by Ach language consultants and closer to [ɔo] by KpA language consultants.

5.2.3.6 The production of /ɔə/ in *toe*

The F1 and F2 ROC average values for Ach [ɔə] in *toe* (Appendix N.6.1 and N.6.2) are slightly larger than KpA [ɔə] (see Appendix O.6.1 and O.6.2) and this suggest that Ach language consultants produced it with more diphthongal movement compared to KpA language consultants. However, in the F1 and F2 ROC average values from both groups of language consultants, no significant differences were found (F1: $t(58)=0.51$, $p=0.306$; F2: $t(58)=0.6$, $p=0.275$). Furthermore, the negative F2 ROC average values from both groups of language consultants illustrate trajectories moving towards the back of the vowel space as shown in Figure 5.15. The trajectory of this diphthong by Ach language consultants is seen to move towards a high back position approximating /u/, suggesting that it was realized closer to [ɔu]. Whilst for KpA language consultants, it is seen to move towards /o/, sounding similar to [ɔo].

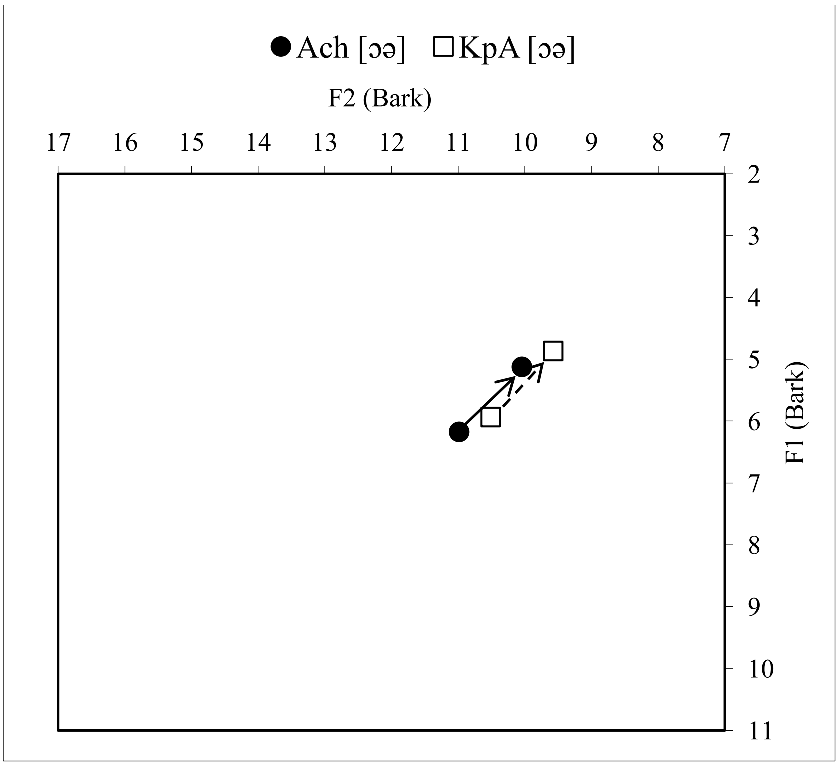


Figure 5.15: Trajectories of Ach [ɔə] and KpA [ɔə] from *toe*
n.b. /ɔə / in *toe* is realized closer to [ɔu] by Ach language consultants and closer to [ɔo] by KpA language consultants.

5.2.3.7 The production of /ui/ in *bui*

The F1 ROC average value for KpA [ui] in *bui* is bigger (see Appendix N.7.1 and N.7.2) than Ach [ui] (see Appendix O.7.1 and O.7.2). This suggests that KpA language consultants produced it with more diphthongal movement compared to Ach language consultants. Nonetheless, in the F1 and F2 ROC average values from both groups of language consultants, no significant differences were found (F1: t(58)=1.18, p=0.121; F2: t(58)=0.31, p=0.379). Figure 5.16 clearly shows similar trajectories for [ui] produced by both groups of language consultants.

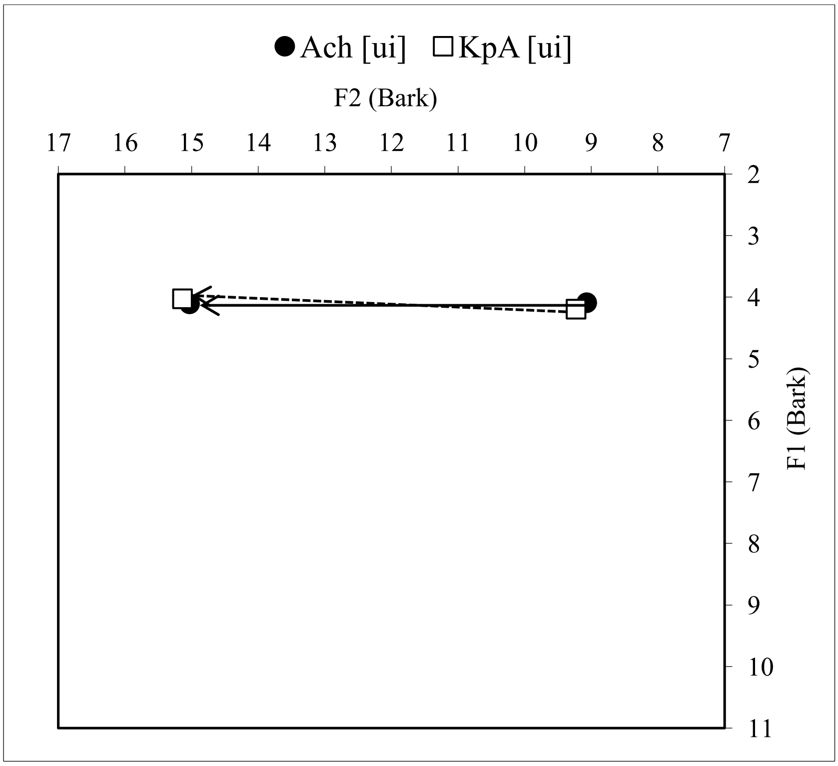


Figure 5.16: Trajectories of Ach [ui] and KpA [ui] from *bui*

5.2.3.8 The production of /əi/ in *hei*

A larger F1 ROC average value for [əi] in *hei* by Ach language consultants (see Appendix N.8.1 and N.8.2) suggests that it was produced with a greater diphthongal movement compared to KpA language consultants (see Appendix O.8.1 and O.8.2). Significant differences were found in the F1 and F2 ROC average values (F1: $t(55)=7.22$, $p<.0001$; F2: $t(55)=5.87$, $p<.0001$). This means that it was produced differently by both language consultants. Figure 5.17 shows the movement of [əi] by Ach and KpA language consultants. The onset of [əi] by KpA language consultants is seen to be produced further back approximating /o/, suggesting a realization closer to [oi].

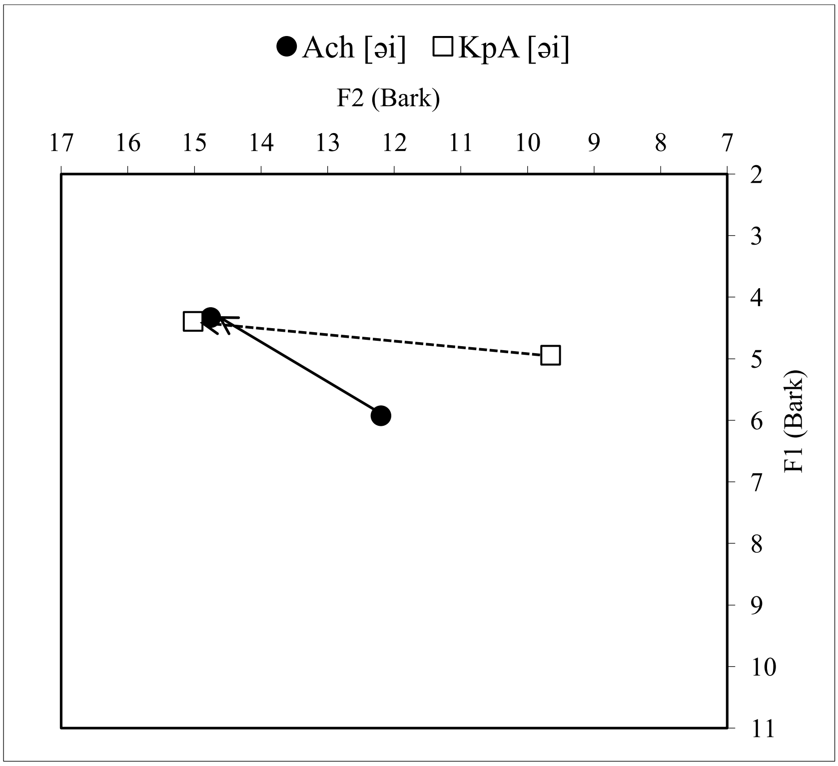


Figure 5.17: Trajectories of Ach [əi] and KpA [əi] from *hei*
n.b. /əi/ in *hei* is realized closer to [oi] by KpA language consultants.

5.2.3.9 The production of /oi/ in *bhôi*

The smaller F1 ROC average value of [oi] in *bhôi* by Ach language consultants (see Appendix N.9.1 and N.9.2) suggests that it was produced with a lesser movement compared to KpA language consultants (see Appendix O.9.1 and O.9.2). However, no significant differences were found in the F1 and F2 ROC average values between both groups of language consultants (F1: $t(58)=3.09$, $p=0.002$; F2: $t(58)=1.28$, $p=0.103$). Figure 5.18 illustrates the trajectories of this diphthong that are similar from both groups of language consultants.

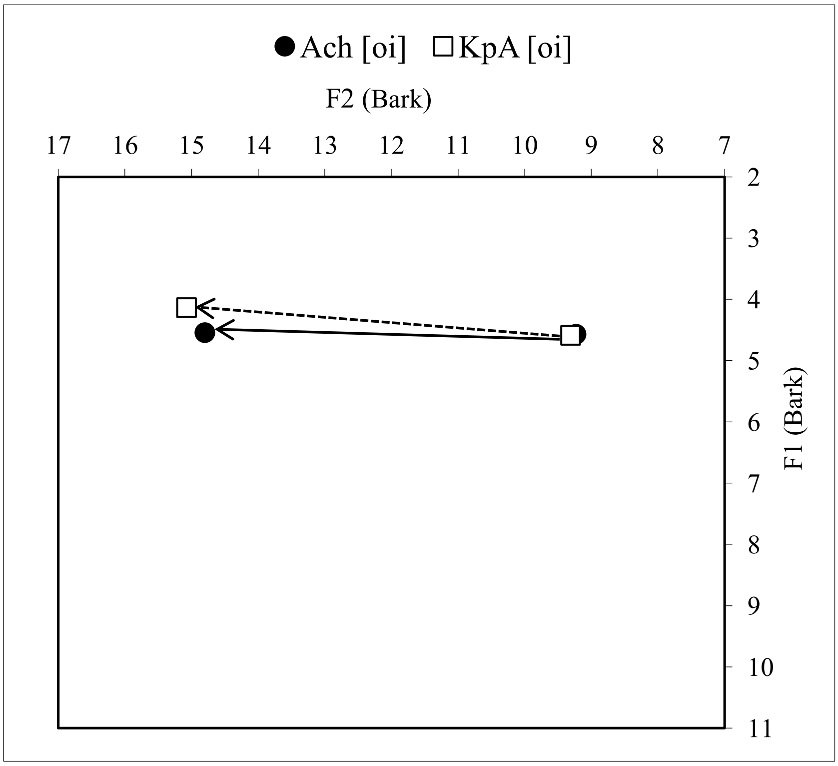


Figure 5.18: Trajectories of Ach [oi] and KpA [oi] from *bhôi*

5.2.3.10 The production of /ʌi/ in *lagöina*

Based on the F1 ROC average value of Ach [ʌi] in *lagöina* (see Appendix N.10.1 and N.10.2), it was produced with a greater diphthongal movement compared to KpA [ʌi] (see Appendix O.10.1 and O.10.2). A significant difference was found in the F1 ROC average values (t(58)=5.78, p<.0001), but no significant difference was found in the F2 ROC average values (t(58)=1.82, p=0.037). Figure 5.19 reflects their trajectories. For KpA language consultants, it is seen that this diphthong started at a further back position approximating /ɔ/ and ended at a position closer to /e/, suggesting a production of a diphthong closer to [ɔe].

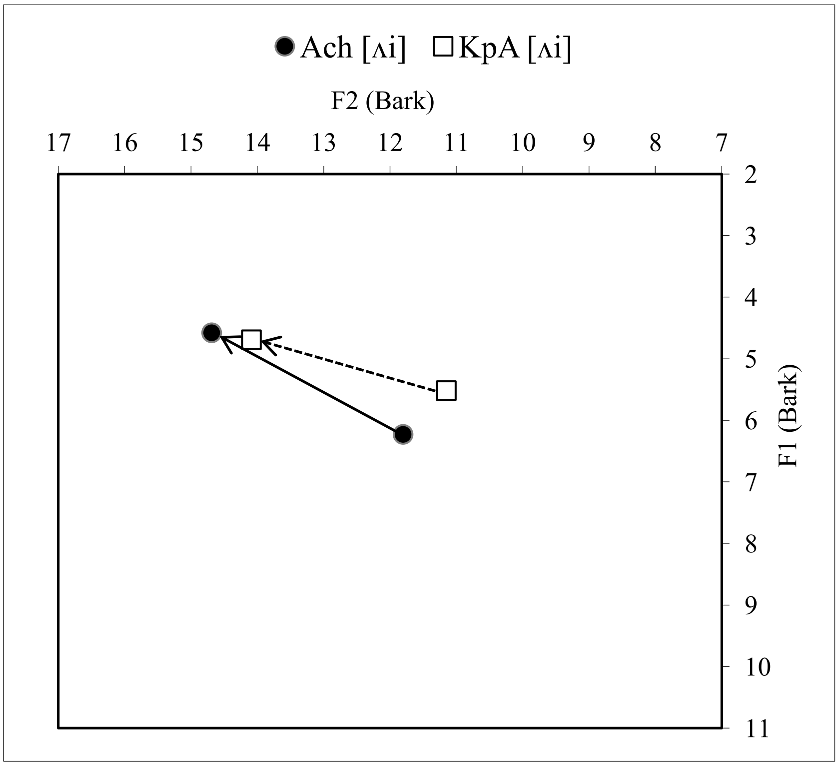


Figure 5.19: Trajectories of Ach [ʌi] and KpA [ʌi] from *lagöina*
n.b. /ʌi/ from *lagöina* is realized closer to [ɔe] by KpA language consultants.

5.2.3.11 The production of /ɔi/ in *poih*

Ach [ɔi] in *poih* has larger F1 and F2 ROC average values (see Appendix N.11.1 and N.11.2) compared to KpA [ɔi] (see Appendix O.11.1 and O.11.2), and this suggests that Ach [ɔi] was produced with greater diphthongal movement. However, no significant differences were found in the F1 and F2 ROC average values (F1: $t(58)=3.84$, $p=0.0002$; F2: $t(58)=3.04$, $p=0.002$). In Figure 5.20, it shows that the offset of this diphthong by Ach language consultants was produced closer to [ɔə] as its trajectory moves towards the center of the vowel space instead of to the front position. For KpA language consultants, this diphthong is also seen to move from the low back position towards the front of the vowel space, suggesting a realization closer to [oe].

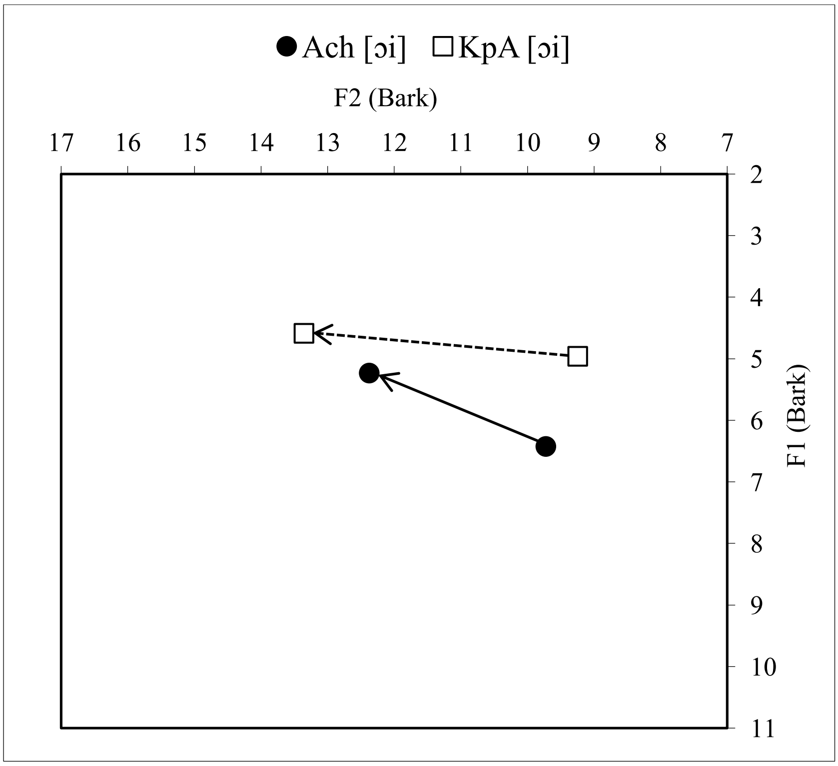


Figure 5.20: Trajectories of Ach [ɔi] and KpA [ɔi] from *poih*
n.b. /ɔi/ in *poih* was realized closer to [oe] by KpA language consultants.

5.2.3.12 The production of /ai/ in *jai*

Between Ach [ai] and KpA [ai] in *jai*, no significant differences were found in the F1 and F2 ROC average values (F1: $t(58)=0.03$, $p=0.488$; F2: $t(58)=1.14$, $p=0.130$). Both groups of language consultants (see Appendix N.12.1 and N.12.2 for Ach, and Appendix O.12.1 and O.12.2 for KpA) appeared to produce the diphthong in the word *jai* similarly. Figure 5.21 further shows similar trajectories of the diphthong produced by both groups of language consultants.

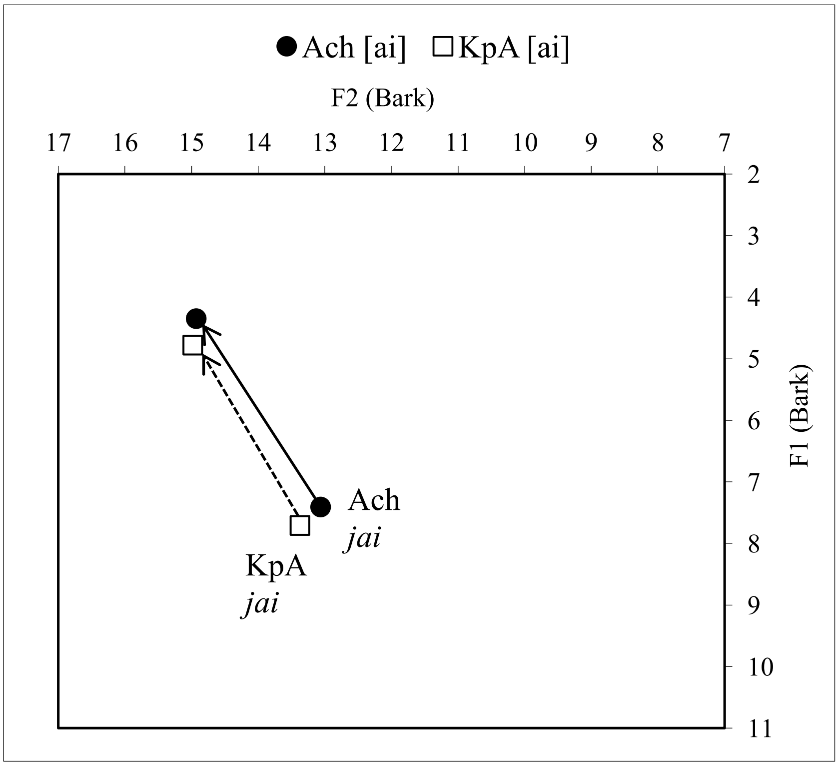


Figure 5.21: Trajectories of Ach [ai] and KpA [ai] from *jai*

5.3 Diphthongs from INT

From INT, a total of 1347 tokens were selected for the measurements of twelve vowels from both Ach (see Appendix P) and KpA language consultants (see Appendix Q). Table 5.5 and Table 5.6 show the total number of tokens selected for each vowel from Ach and KpA language consultants.

Table 5.5: Ach Diphthongs from INT

Ach Diphthongs	Number of selected tokens
iə	73
ɯə	157
uə	124
ɛə	199
ʌə	4
ɔə	61
ui	1
əi	14
oi	8
ʌi	0
ɔi	0
ai	104
Total	**745**

Table 5.6: KpA Diphthongs from INT

KpA Diphthongs	Number of selected tokens
iə	39
ɯə	97
uə	101
ɛə	179
ʌə	0
ɔə	58
ui	1
əi	0
oi	29
ʌi	0
ɔi	0
ai	97
Total	**601**

From Table 5.5, the diphthongs [ʌi] and [ɔi] by Ach language consultants were not found in INT. Furthermore, only one instance of [ui] was found in the selected environment. Similarly, in Table 5.6, it also shows that [ʌi], [ɔi] and an additional [əi] by KpA language consultants were not found in INT. The diphthong [ui] was also only measured from one token found. Parallel to WE, the tokens in Table 5.5 and Table 5.6 were calculated for their ROC values for both F1 and F2 at the beginning and ending of each diphthong. The following Figures show the trajectories of diphthongs in the vowel space, the two ends of the arrow represent the onset and offset of a diphthong. The production of diphthongs by each group is further discussed in the following 5.3.1 and 5.3.3.

5.3.1 Ach Diphthongs from INT

For Ach language consultants, a number of 745 tokens were measured in total, with 618 tokens for centering diphthongs and another 127 tokens for rising diphthongs.

5.3.1.1 Ach Centering Diphthongs from INT

Table 5.7 presents the F1 and F2 ROC average values for each centering diphthongs by Ach language consultants from INT and SD are in parentheses.

Table 5.7: F1 and F2 ROC Average Values, and SD for Ach Centering Diphthongs

Diphthongs	F1 ROC and SD (Hz/sec)	F2 ROC and SD (Hz/sec)
iə	846 (1041)	-4804 (7004)
ɯə	144 (1033)	-1917 (4687)
uə	696 (1032)	2100 (4201)
ɛə	-234 (1181)	-2828 (4031)
ʌə	-342 (1179)	-1986 (723)
ɔə	-325 (1280)	-241 (3659)

Based on Table 5.7, the small F1 and F2 ROC average values for Ach [ɯə] and [ɛə] indicate small movements from the onset to offset of these vowels, and this is confirmed by the movements of these diphthongs captured in Figure 5.22. In WE, the movement of [ɛə] (see 5.2.1.1 and 5.2.3.4) is seen to be smaller compared to INT where some movement is observable for this diphthong. Figure 5.22 further shows that the movement of [ʌə] and [ɔə] are similar to WE (see 5.2.1.1, 5.2.3.5 and 5.2.3.6) because their trajectories also move towards the back of the vowel space instead of to the center as proposed by Asyik (1987). For Figure 5.22, every centering diphthong average measurement in Bark for Ach language consultants from INT are provided in Appendices P.1.1 to P.6.2.

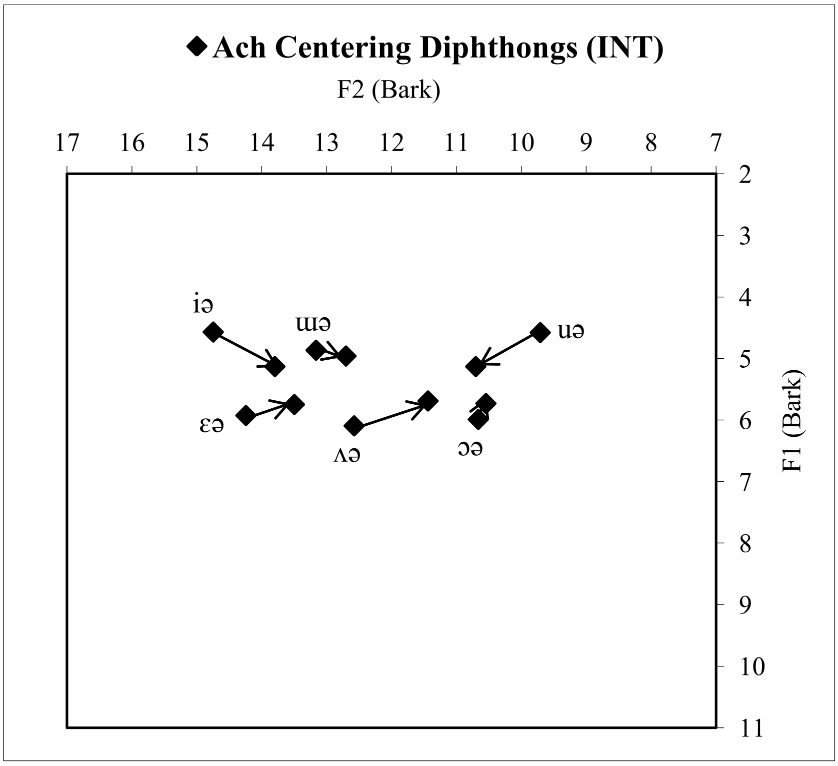


Figure 5.22: Diphthongal movements for Ach centering diphthongs from INT

5.3.1.2 Ach Rising Diphthongs from INT

Table 5.8 shows the F1 and F2 ROC average values for each rising diphthong by Ach language consultants from INT and SD are in parentheses.

Table 5.8: F1 and F2 ROC Average Values, and SD for Ach Rising Diphthongs

Diphthongs	F1 ROC and SD(Hz/sec)	F2 ROC and SD (Hz/sec)
ui	0 (0)	7685 (0)
əi	-765 (893)	5891 (3422)
oi	-431 (1687)	11123 (7442)
ʌi	0	0
ɔi	0	0
ai	-2290 (1609)	3900 (3031)

Table 5.8 shows that the larger F1 ROC average value for Ach [ai] indicates greater formant movement in vowel height compared to other vowels, whereas the zero F1 ROC average value for [ui] shows a lack of change in vowel height for this sound. Again, [ui] was only extracted in one word from INT; therefore, the result must be treated with caution. Unfortunately, no instances of /ʌi/ and /ɔi/ in the selected environment were found from INT; therefore, no analysis was conducted on these vowels from this set of data. Figure 5.23 shows that all diphthongs demonstrated the back to front trajectories of these diphthongs based on the positive F2 ROC average values in Table 5.8. Every rising diphthong average measurement in Bark for Ach language consultants from INT are provided in Appendices P.7.1 to P.12.2.

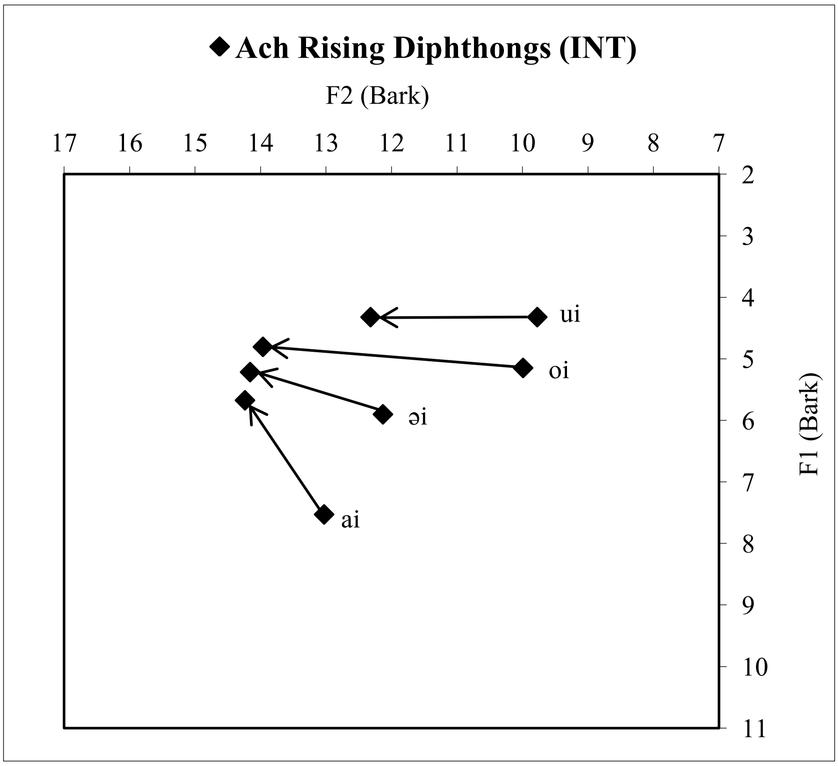


Figure 5.23: Diphthongal movements for Ach rising diphthongs from INT

5.3.2 KpA Diphthongs from INT

For KpA language consultants, there were 602 tokens measured in total, with 475 tokens for centering diphthongs and another 127 tokens for rising diphthongs.

5.3.2.1 KpA Centering Diphthongs from INT

Table 5.9 presents the F1 and F2 ROC average values for each centering diphthong by KpA language consultants from INT and SD are in parentheses.

Table 5.9: F1 and F2 ROC Average Values, and SD for KpA Centering Diphthongs

Diphthongs	F1 ROC and SD (Hz/sec)	F2 ROC and SD (Hz/sec)
iə	206 (629)	-243 (3306)
ɯə	94 (538)	201 (3947)
uə	116 (571)	223 (3548)
ɛə	26 (720)	-1242 (3400)
ʌə	0	0
ɔə	-98 (866)	1087 (3083)

Based on the values in Table 5.9, the F1 ROC average values of KpA centering diphthongs from INT are small; therefore, it is assumed that very little movements in vowel height occurred for all of the diphthongs. Even though they are very small, the positive F2 ROC average values from [ɯə], [uə] and [ɔə] reflect the back to front trajectories of these vowels. On the other hand, the small negative F2 ROC average values from [iə] and [ɛə] reveal that these diphthongs are moving towards the center of the vowel space. However, the trajectories of these diphthongs in Figure 5.24 show no movement in the production of [iə], [ɯə], [uə], and suggests monophthongization of these diphthongs by this group of language consultants. Very little movement is further seen in the trajectory of [ɛə]. As for [ɔə], instead of moving towards the back of the vowels space such as in WE, INT shows that its trajectory is moving towards the center of the vowel even though the movement is very small. For Figure 5.24, every centering diphthong average measurement in Bark for KpA language consultants from INT are provided in Appendices Q.1.1 to Q.6.2.

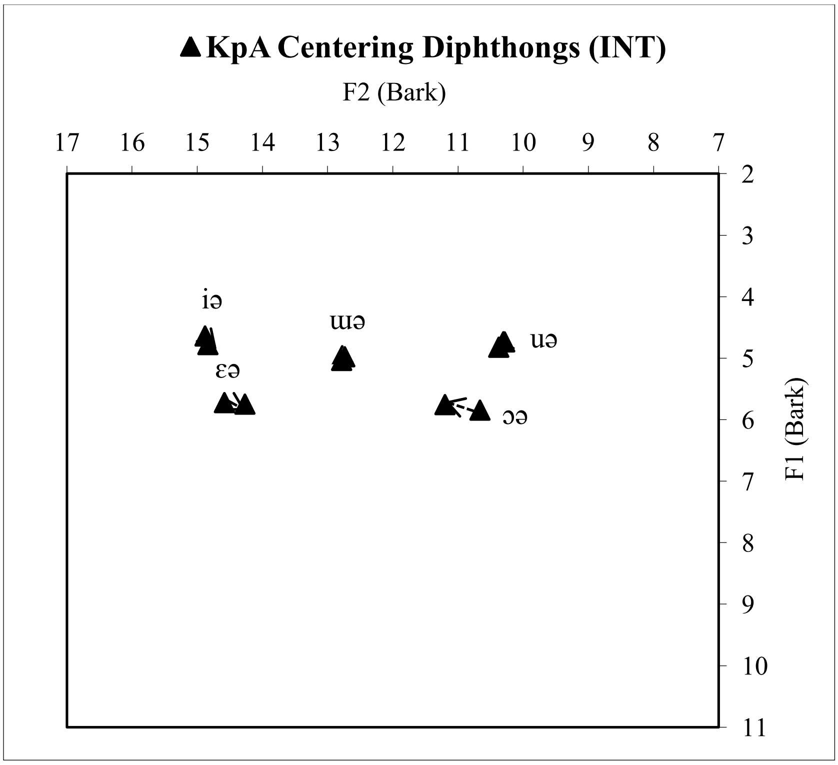


Figure 5.24: Diphthongal movements for KpA centering diphthongs from INT

5.3.2.2 KpA Rising Diphthongs from INT

Table 5.10 shows the F1 and F2 ROC average values for each rising diphthong by KpA language consultants from INT and SD are in parentheses.

Table 5.10: F1 and F2 ROC Average Values, and SD for KpA Rising Diphthongs

Diphthongs	F1 ROC and SD (Hz/sec)	F2 ROC and SD (Hz/sec)
ui	-430 (0)	17215 (0)
əi	-88 (548)	11409 (3198)
oi	-10 (729)	9453 (3752)
ʌi	0	0
ɔi	0	0
ai	-941 (1340)	3144 (3637)

Table 5.10 shows that the larger F1 ROC average value for KpA [ai] indicates greater formant movement in vowel height compared to the other vowels, while the small F1 ROC average value for [oi] indicates a lack of change in vowel height for these diphthongs. Still, the F2 ROC average values for all vowels mirror the back to front trajectories of these diphthongs. This is represented in Figure 5.25. Every rising diphthong average measurement in Bark for KpA language consultants from INT are provided in Appendices Q.7.1 to Q.12.2.

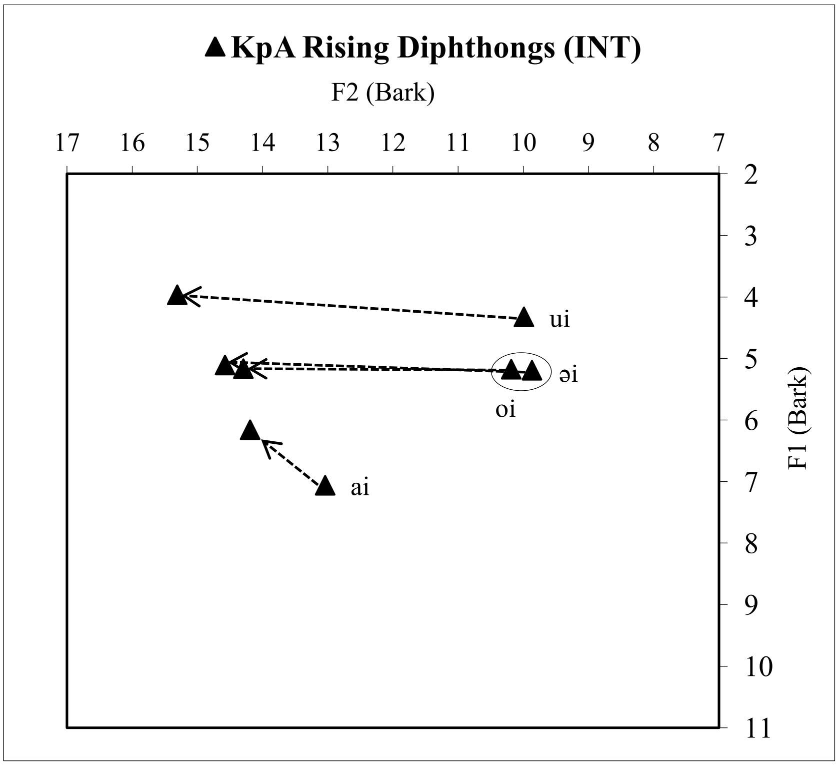


Figure 5.25: Diphthongal movements for KpA rising diphthongs from INT
n.b. /əi/ was realized closer to [oi] by KpA language consultants.

Similar to WE, again it was found that words with /əi/ were realized as [oi], as can be seen in their close proximity trajectories in Figure 5.25. From INT, all instances of *hei* 'to call' with [əi] by Ach language consultants were pronounced as *hôi* with [oi] by KpA language consultants. Therefore, t-tests were conducted to compare [oi] in *hôi* (12 tokens) and other [oi] sounds found in INT (17 tokens) from KpA language consultants, and the results showed no significant differences in the F1 and F2 ROC average values (F1: $t(27)=0.89$, $p=0.191$; F2: $t(27)=1.83$, $p=0.039$), indicating that they were produced similarly. Unfortunately, no instances of /ʌi/ and /ɔi/ were found in this speaking context, therefore, further analysis could not be conducted on these sounds from this set of data.

5.3.3 Ach vs. KpA Diphthongs from INT

This section further elaborates the comparison of diphthong productions between Ach and KpA language consultants. Based on their ROC average values and trajectories in the vowel space, each diphthong is discussed.

5.3.3.1 The production of /iə/

For /iə/, eight words were selected to extract the diphthong from INT as shown in

Table 5.1111, with 73 tokens from Ach language consultants (see Appendix P.1.1 and P.1.2) and another 39 tokens from KpA language consultants (see Appendix Q.1.1 and Q.1.2).

Table 5.11: Words to Elicit /iə/

No	Words	Gloss	Ach	KpA
1	*b**ie**k*	ancestor		✓
2	*maks**ie**t*	immoral (behavior)	✓	
3	*Pid**ie***	name of district	✓	
4	*s**ie***	meat		✓
5	*teub**ie**t*	exit	✓	✓
6	*t**ie**k*	throw	✓	✓
7	*t**ie**p*	every		✓
8	*was**ie**t*	will		✓
Total number of words			4	6
Total number of tokens			73	39

n.b. ✓ means the group of speakers produced the word.

Ach [iə] can be said to be produced with greater diphthongal movement than KpA [iə] because both F1 and F2 ROC average values for Ach language consultants are larger than KpA language consultants. T-tests showed that there was no significant differences between Ach [iə] and KpA [iə] in the F1 ROC average values (t(110)=3.61, p=0.000), thus, a significant difference was found in the F2 ROC average values (t(110)=3.88, p<.0001). Figure 5.26 shows trajectories of [iə] produced by Ach and KpA language consultants. It illustrates that Ach [iə] has more movement compared to KpA [iə] that hardly moved from one point to another.

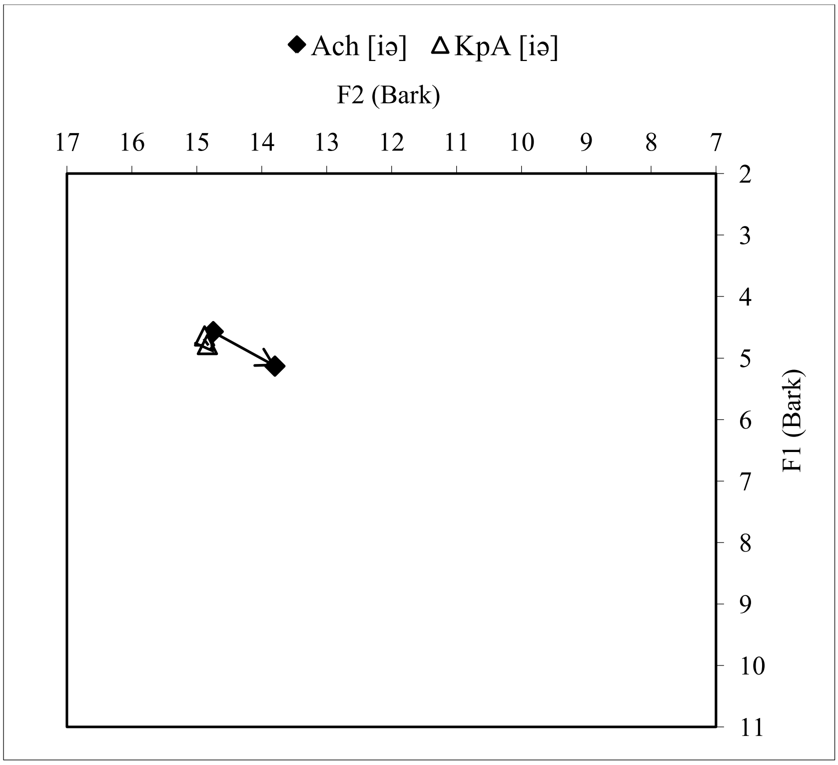


Figure 5.26: Trajectories of Ach [iə] and KpA [iə] from INT
n.b. /iə/ is realized closer to [i] by KpA language consultants.

A comparative examination between the vowel production from WE and INT were also conducted to study their productions in the two different speaking contexts. Figure 5.27 shows the trajectories of Ach [iə] from WE and INT, and it is seen that the trajectories from onset [i] towards the center of the vowel space is visible for both of them. T-tests conducted between the two speaking contexts also showed no significant differences in the F1 and F2 ROC average values (F1: t(101)=2.2, p=0.015; F2: t(101)=1.34, p=0.092). Therefore, the production of [iə] in both speaking contexts was maintained by Ach language consultants.

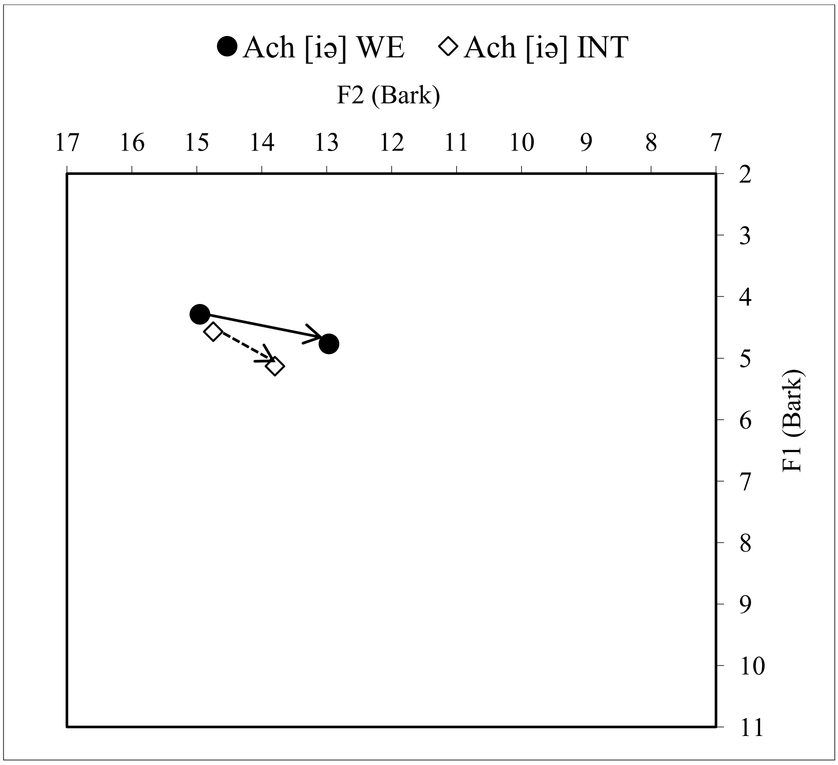


Figure 5.27: Trajectories of Ach [iə] from WE and INT

Furthermore, Figure 5.28 presents the trajectories of KpA [iə] from WE and INT, and no movement at all is seen for this vowel from both speaking contexts. This is further confirmed by t-tests between the two speaking contexts that showed no significant differences in the F1 and F2 ROC average values (F1: t(67)=2.46, p=0.008; F2: t(67)=0.69, p=0.246). Furthermore, t-tests between KpA [iə] and KpA [i] from INT also showed no significant difference in the average durations (t(333)=2.03, p=0.022), indicating that they were produced with similar duration. Figure 5.29 shows the trajectories of KpA [iə] from both speaking contexts and the plot of KpA [i] also from both contexts. Their productions are seen to be very close together, which suggest that KpA language consultants realized [iə] as a monophthong [i] in both speaking contexts.

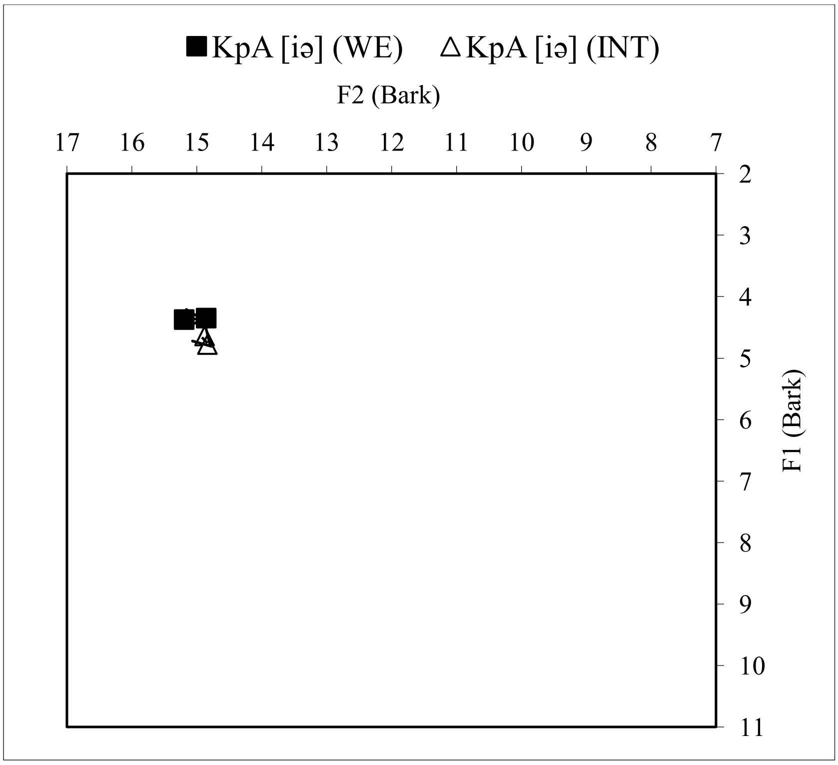


Figure 5.28: Trajectories of KpA [iə] from WE and INT
n.b. /iə/ is realized closer to [i] by KpA language consultants in both speaking contexts.

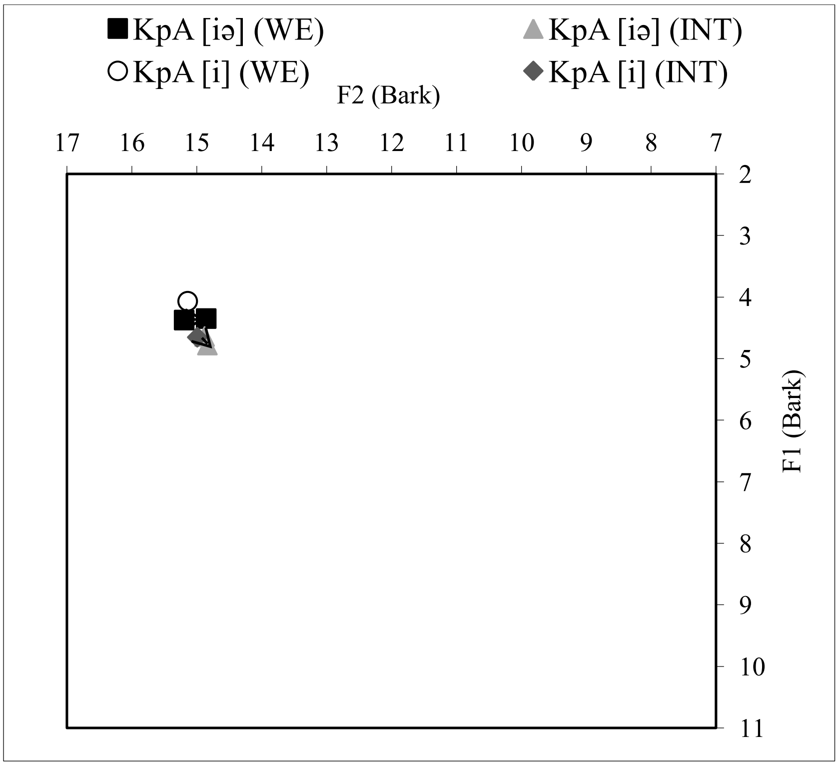


Figure 5.29: Trajectories of KpA [iə] and plot of KpA [i] from WE and INT
n.b. /iə/ is realized closer to [i] by KpA language consultants in both speaking contexts.

5.3.3.2 The production of /ɯə/

A number of ten words were found to extract the sound /ɯə/ from INT as shown in Table 5.12, with 157 tokens from Ach language consultants (see Appendix P.2.1 and P.2.2) and another 97 tokens from KpA language consultants (see Appendix Q.2.1 and Q.2.2).

Table 5.12: Words to Elicit /ɯə/

No	Words	Gloss	Ach	KpA
1	*at**eue**h*	up	✓	✓
2	*b**eue**t*	study, recite Al-Qur'an	✓	✓
3	*d**eue**h*	see, visible	✓	
4	*d**eue**k*	hungry	✓	✓
5	*gap**eue**h*	cotton	✓	
6	*j**eue**t*	can, able	✓	✓
7	*keumb**eue***	twin		✓
8	*sad**eue***	lean	✓	

‘Table 5.12, continued’

9	*teu**jeue**t*	brave	✓	
10	*wak**eueh***	inherit		✓
Total number of words			8	6
Total number of tokens			157	97

n.b. ✓ means the group of speakers produced the word.

The F1 and F2 ROC average values of KpA [ɯə] are smaller than that of Ach [ɯə]. Figure 5.30 also shows that there is a lack of movement for KpA [ɯə] compared to Ach [ɯə], which implies that KpA language consultants may produced it as [ɯ]. This is confirmed by t-tests that showed no significant difference was found in the F1 ROC average values of Ach [ɯə] and KpA [ɯə] (t(252)=0.16, p=0.437), but a significant difference was found in the F2 ROC average values (t(252)=3.78, p<.0001).

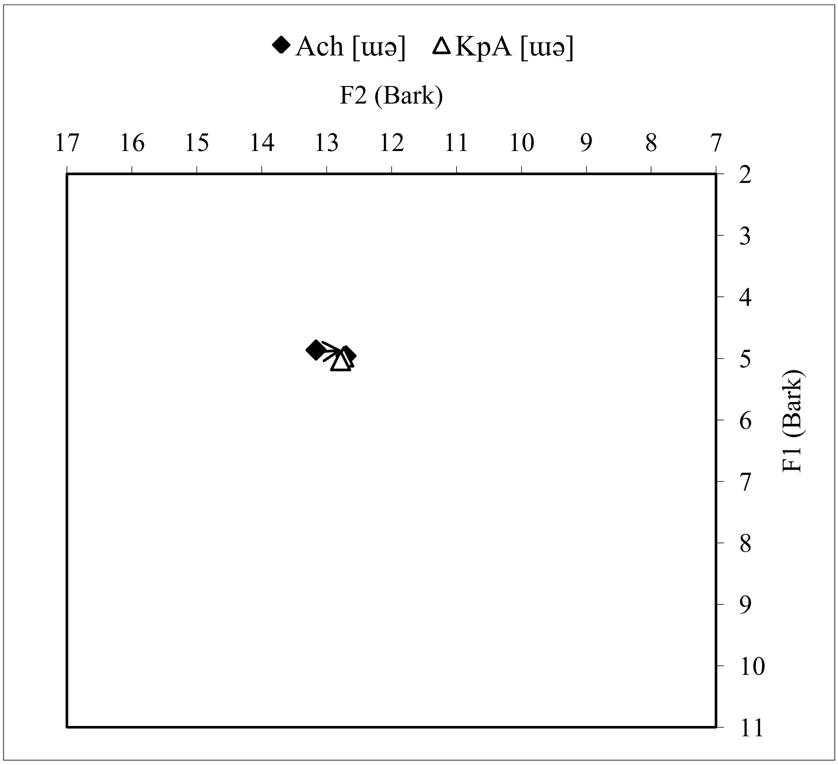


Figure 5.30: Trajectories of Ach [ɯə] and KpA [ɯə] from INT
n.b. /ɯə/ is realized closer to /ɯ/ by KpA language consultants.

Moreover, t-tests between Ach [ɯə] from WE and INT showed that there was no significant difference in the F1 ROC average values ($t(185)=2.72$, $p=0.004$), but a significant difference in the F2 ROC average values ($t(185)=6.97$, $p<.0001$). This indicates that Ach [ɯə] trajectory from WE had more movement compared to INT as shown in Figure 5.31.

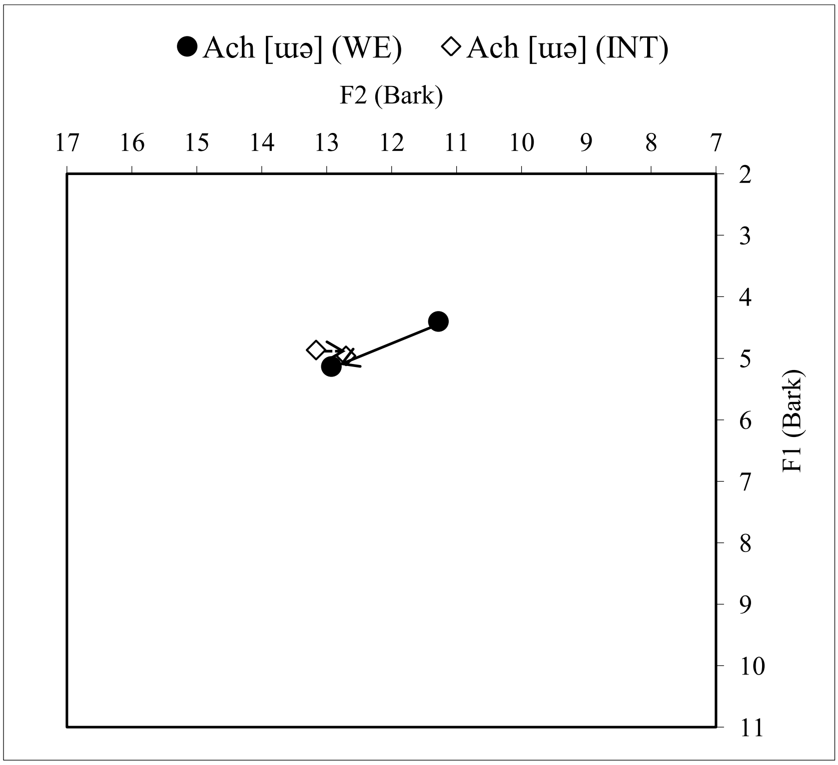


Figure 5.31: Trajectories of Ach [ɯə] from WE and INT

In Figure 5.32, KpA [ɯə] from WE is seen to show more movement than INT, which displays no movement at all. However, t-tests between KpA [ɯə] from WE and INT showed no significant differences in the F1 and F2 ROC average values (F1: $t(125)=3.22$, $p=0.001$; F2: $t(125)=3.51$, $p=0.000$). The duration of KpA [ɯə] from INT (at 0.074 sec) is shorter than KpA [ɯ] from INT (at 0.120 sec), and a t-test between them showed a significant difference in the average durations ($t(279)=6.12$, $p<.0001$).

The trajectories of KpA [ɯə] and KpA [ɯ] from both speaking contexts in Figure 5.33 further suggest KpA [ɯə] was realized closer to [ɯ] in INT.

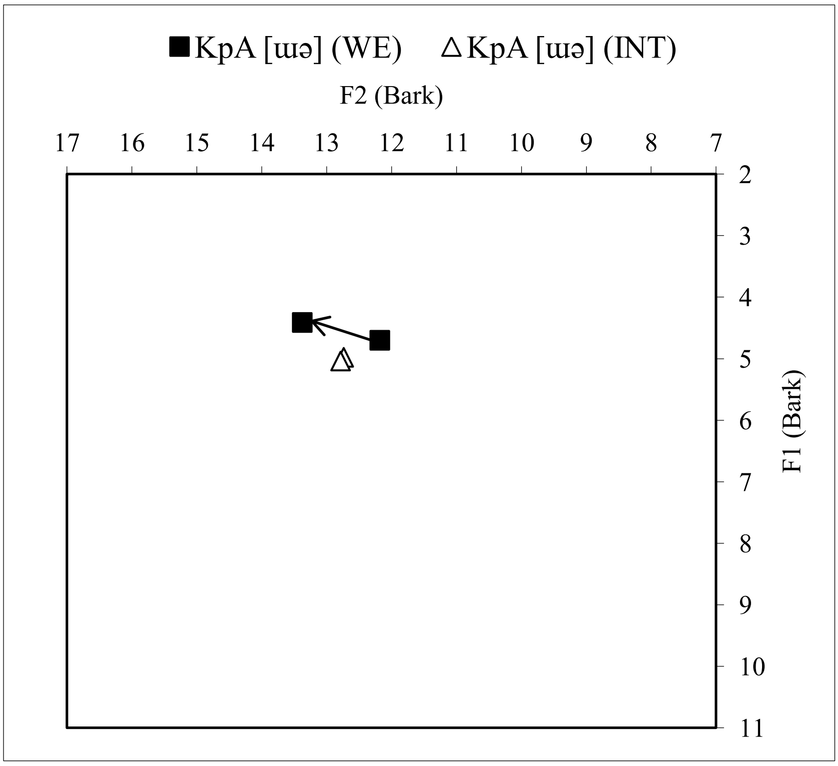


Figure 5.32: Trajectories of KpA [ɯə] from WE and INT
n.b. /ɯə/ is realized closer to [ɯ] by KpA language consultants in INT.

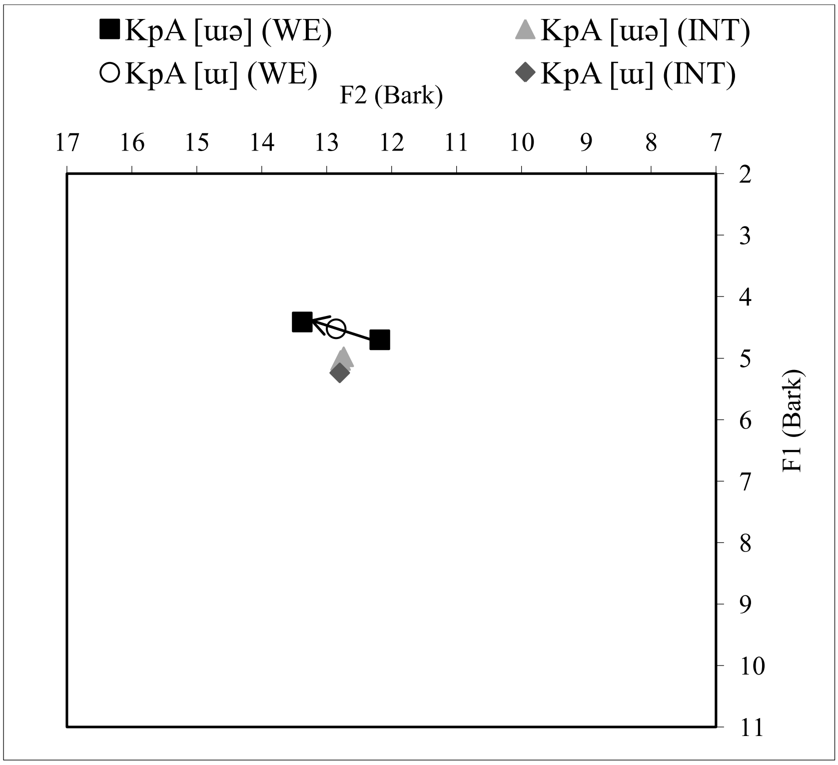


Figure 5.33: Trajectories of KpA [ɯə] and plot of KpA [ɯ] from WE and INT
n.b. /ɯə/ is realized closer to [ɯ] by KpA language consultants in INT.

5.3.3.3 The production of /uə/

There were 11 words that were used to extract /uə/ from INT as shown in Table 5.13, with 124 tokens from Ach language consultants (see Appendix P.3.1 and P.3.2) and 101 tokens from KpA language consultants (see Appendix Q.3.1 and Q.3.2).

Table 5.13: Words to Elicit /uə/

No	Words	Gloss	Ach	KpA
1	*b**ue**t*	work	✓	✓
2	*c**ue***	steal	✓	
3	*d**ue**k*	sit, stay, live	✓	✓
4	*gab**ue**k*	busy	✓	
5	*h**ue***	pull	✓	
6	*keuneulheuh b**ue**t*	at last	✓	
7	*k**ue**h*	dig	✓	
8	*k**ue**t*	collect	✓	✓
9	*peub**ue**t*	to do (something)	✓	

'Table 5.13, continued'

10	*peud**uek***	put, to place	✓	✓
11	*tingk**ue***	carry	✓	
Total number of words			11	4
Total number of tokens			124	101

n.b. ✓ means the group of speakers produced the word.

The F1 and F2 ROC average values from Ach [uə] is larger than KpA [uə] and this suggest that Ach language consultants produced this diphthong with more diphthongal movement than KpA language consultants. Despite that KpA [uə] is seen to have more movement from WE, Figure 5.34 depicts its finding from INT that shows a lack of movement, suggesting [u]. However, it concurs with WE (see 5.2.3.3) that the onset of Ach [uə] from INT is also slightly further back compared to KpA language consultants. Between both groups of language consultants, significant differences were found in the F1 and F2 ROC average values (F1: $t(223)=6.03$, $p<.0001$; F2: $t(223)=3.92$, $p<.0001$). This suggests that [uə] from this set of data was produced differently by both groups of language consultants.

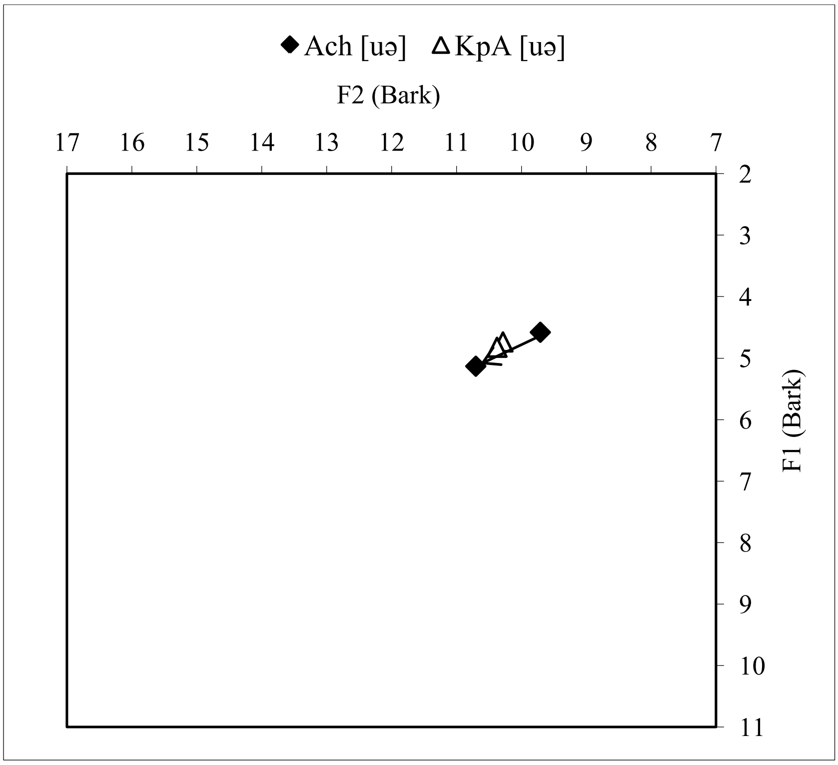


Figure 5.34: Trajectories of Ach [uə] and KpA [uə] from INT
n.b. /uə/ is realized closer to [u] by KpA language consultants.

For Ach [uə] from INT and WE, their trajectories in Figure 5.35 show that WE posed more movement than INT. However, t-tests between the two speaking contexts showed no significant differences in the F1 and F2 ROC average values (F1: $t(152)=0.46$, $p=0.323$; F2: $t(152)=2.32$, $p=0.011$), therefore, [uə] was produced similarly in both speaking contexts by Ach language consultants.

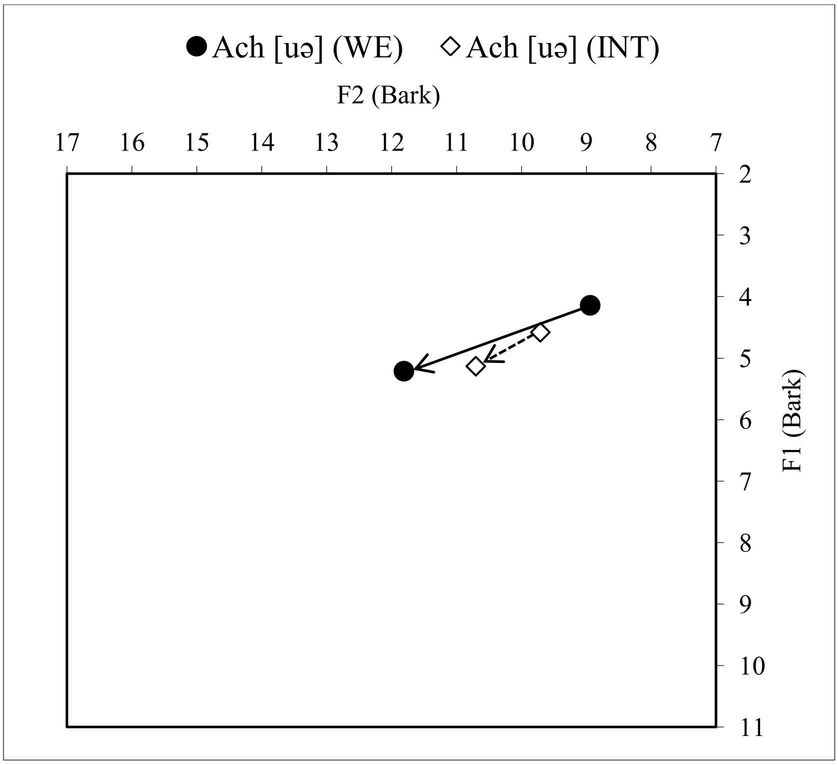


Figure 5.35: Trajectories of Ach [uə] from WE and INT

Furthermore, t-tests for KpA [uə] from WE and INT were also conducted and the results showed that no significant difference was found in the F1 ROC average values (t(129)=0.36, p=0.360), but a significant difference was found in the F2 ROC average values (t(129)= 6.48, p<.0001). This indicates that KpA [uə] from WE was produced with more movement compared to INT as illustrated in Figure 5.36. The duration of KpA [uə] from INT (at 0.085 sec) is shorter than KpA [u] from INT (at 0.099 sec) and a t-test between both also showed no significant difference in the average duration (t(170)=1.62, p=0.054). This suggests that KpA [uə] was realized closer to [u] in INT. The trajectories of KpA [uə] and KpA [u] from both speaking contexts in Figure 5.37 further suggest that KpA [uə] was produced as a monophthong [u] by looking at its very near plot with KpA [u] from INT.

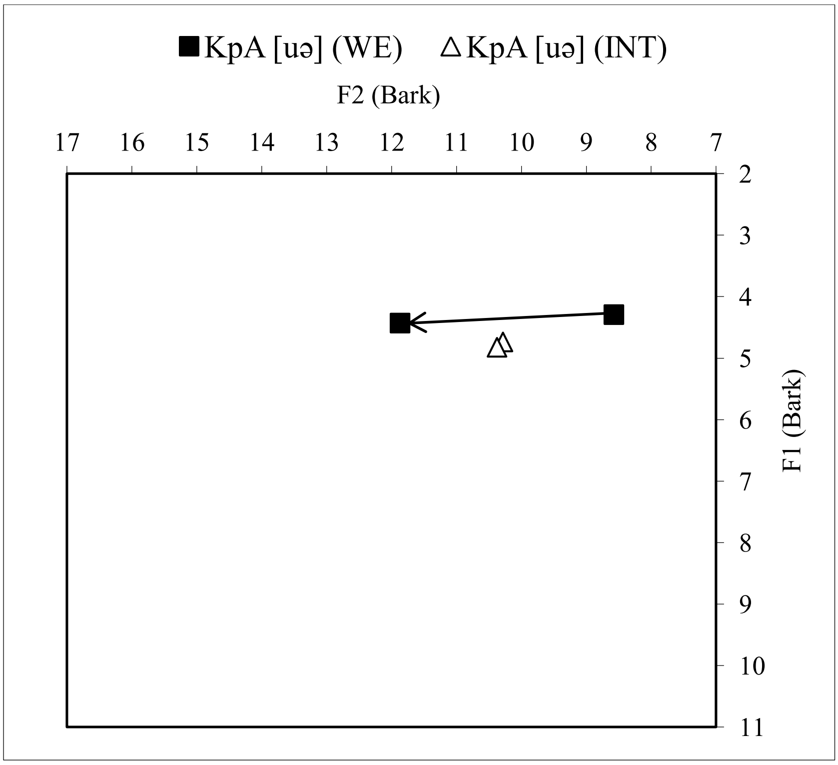


Figure 5.36: Trajectories of KpA [uə] from WE and INT
n.b. /uə/ is realized closer to [u] by KpA language consultants in INT.

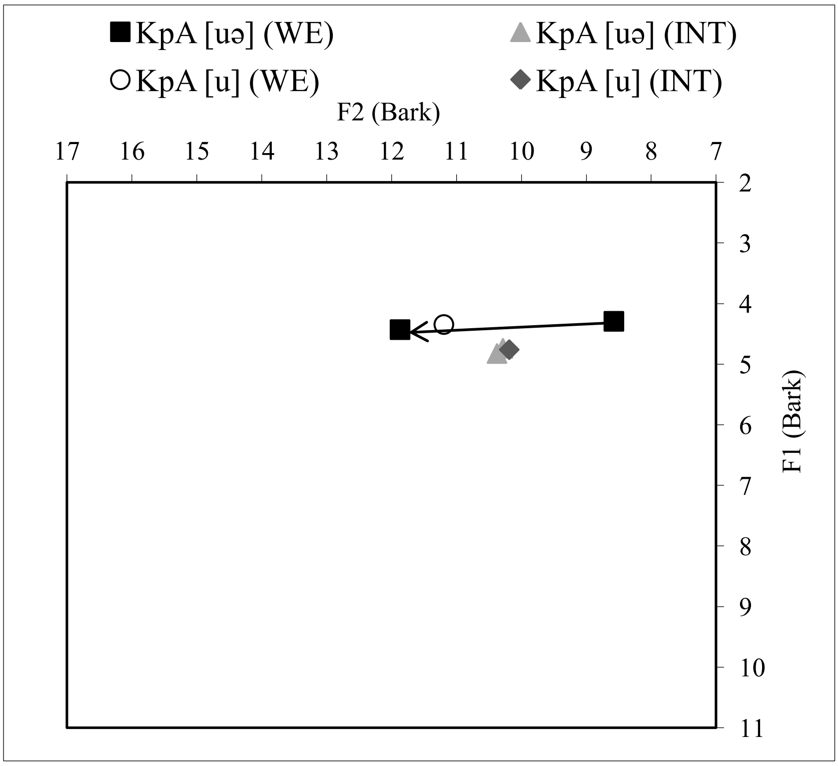


Figure 5.37: Trajectories of KpA [uə] and plot of KpA [u] from WE and INT
n.b. /uə/ is realized closer to [u] by KpA language consultants in INT.

5.3.3.4 The production of /ɛə/

From INT, 20 words were selected to extract /ɛə/ as shown in Table 5.14, with 199 tokens from Ach language consultants (see Appendix P.4.1 and P.4.2) and 179 tokens from KpA language consultants (see Appendix Q.4.1 and Q.4.2).

Table 5.14: Words to Elicit /ɛə/

No	Words	Gloss	Ach	KpA
1	*ab**èe***	dust		✓
2	*ad**èe***	to dry	✓	✓
3	***bèe***	smell	✓	
4	*baj**èe***	clothes	✓	✓
5	*bat**èe***	stone		✓
6	*gès**èe***	slide, move over	✓	
7	*Geurut**èe***	name (of mountain)	✓	
8	*Jambo Tap**èe***	name (of area)	✓	
9	*keud**èe***	shop	✓	✓
10	*lag**èe***	such as	✓	✓
11	*lak**èe***	ask for, want	✓	✓
12	*leund**èe***	mucus, slime		✓
13	*met**èe***	meter	✓	
14	*meulint**èe***	in-law	✓	✓
15	*rib**èe***	thousand	✓	✓
16	*singk**èe***	elbow	✓	
17	*teunt**èe***	certain	✓	✓
18	*th**èe***	realize	✓	
19	*ub**èe***	size	✓	
20	*wat**èe***	time, when	✓	✓
Total number of words			17	12
Total number of tokens			199	179

n.b. ✓ means the group of speakers produced the word.

Significant differences were found in the F1 and F2 ROC average values between Ach [ɛə] and KpA [ɛə] (F1: $t(376)=3.93$, $p<.0001$; F2: $t(376)=4.79$, $p<.0001$), therefore, they were produced differently. From Figure 5.38, it also demonstrates that this diphthong was produced by KpA language consultants with a lack of movement in the vowel space and this set of data also suggests that [ɛə] was produced as a monophthong [ɛ].

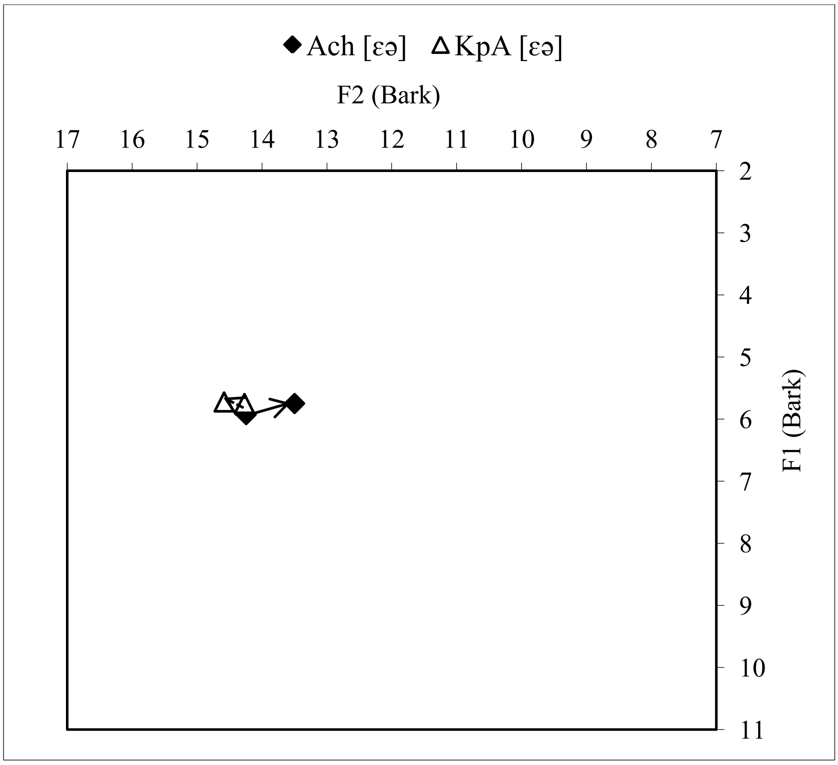


Figure 5.38: Trajectories of Ach [ɛə] and KpA [ɛə] from INT

Additionally, Figure 5.39 shows the trajectories of Ach [ɛə] from WE and INT and it illustrates that [ɛə] production from INT has more movement than WE. This is further confirmed by t-tests that showed that there was no significant difference in the F1 ROC average values ($t(227)=2.49$, $p=0.007$), but a significant difference in the F2 ROC average values ($t(227)=4.15$, $p<.0001$). This suggests that Ach language consultants have [ɛə] in their vowel inventory as asserted by Asyik (1987), Durie (1985) and Sulaiman, Jusuf, Hanum, Lani & Ali (1977).

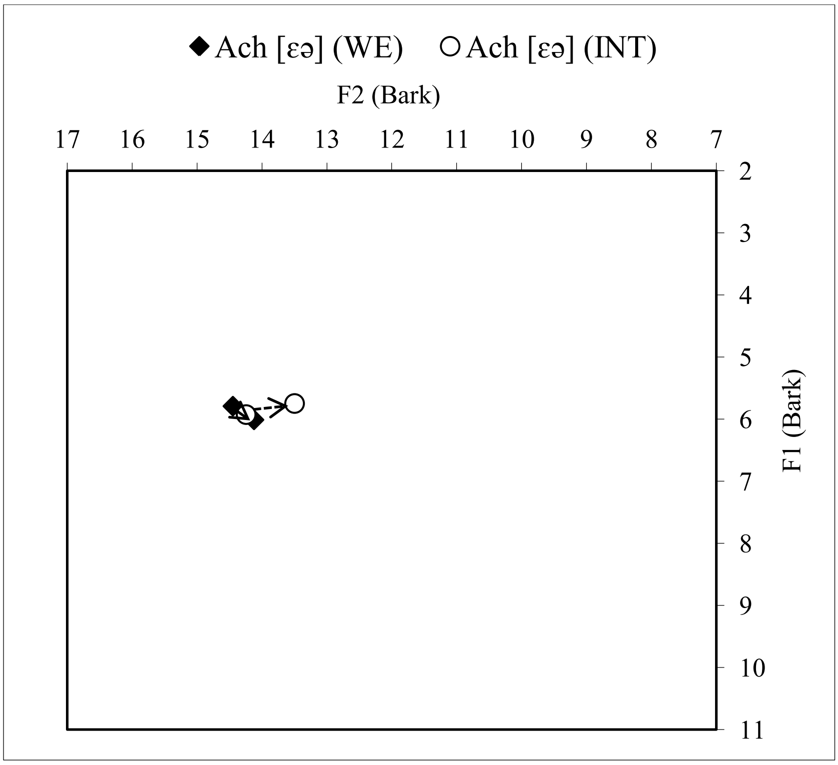


Figure 5.39: Trajectories of Ach /ɛə/ from WE and INT

Figure 5.40 shows the trajectories of [ɛə] by KpA language consultants from WE and INT and it is seen that both show no movement from one vowel point to another in the vowel space. This is confirmed by t-tests that showed no significant differences in the F1 and F2 ROC average values from both speaking contexts (F1: t(208)=0.32, p=0.375; F2: t(208)=2.81, p=0.003). In WE, KpA [ɛə] was realized as a long monophthong [ɛː] (see 5.2.3.4) based on its average duration that was longer compared to its [ɛ]. However, in INT, KpA [ɛə] had a shorter average duration at 0.102s compared to its [ɛ] at 0.118s. A t-test between INT and WE in the production of [ɛə] also showed a significant difference in the average durations (t(207)=8.09, p<.0001). This suggests that KpA [ɛə] in INT was realized as monophthong [ɛ]. In addition, Figure 5.41 shows the trajectories of KpA [ɛə] and plot of KpA [ɛ] from both speaking contexts. It illustrates that they were produced close to each other and this further confirms that KpA language consultants had lost /εə/ in their Acehnese and realized it closer to [ε].

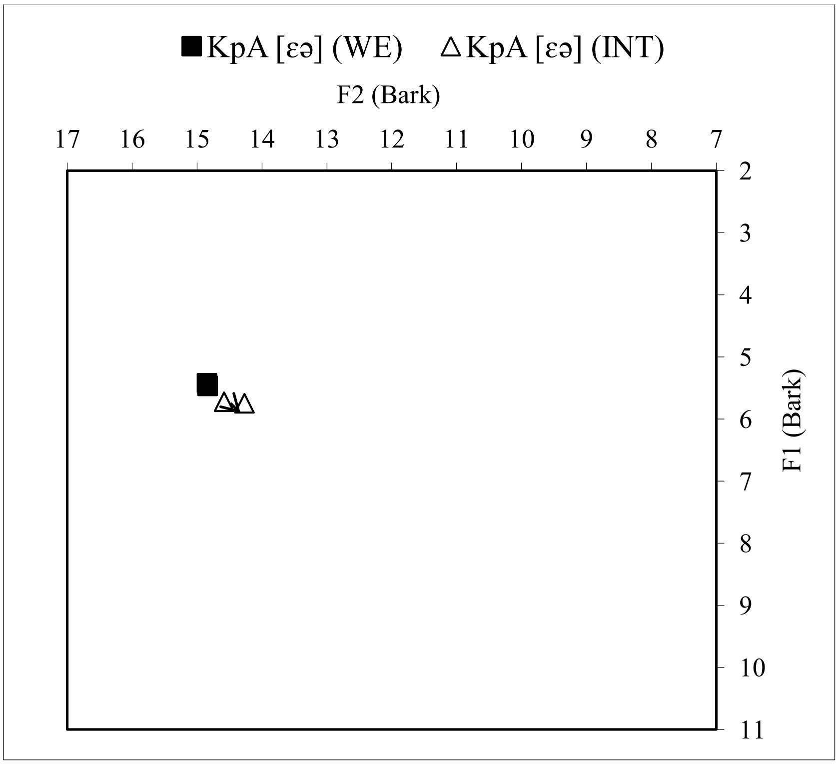


Figure 5.40: Trajectories of KpA [εə] from WE and INT
n.b. /εə/ is realized as [ε] by KpA language consultants in both speaking contexts.

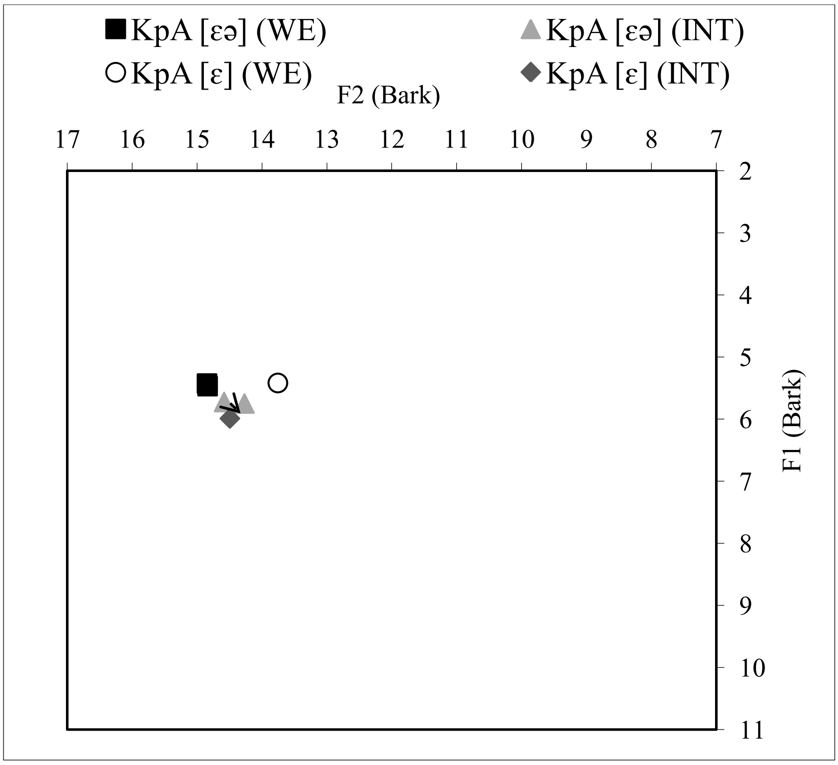


Figure 5.41: Trajectories of KpA [ɛə], and plot of KpA [ɛ] from WE and INT
n.b. /ɛə/ is realized as [ɛ] by KpA language consultants in both speaking contexts.

5.3.3.5 The production of /ʌə/

Unfortunately, no instances of words in the selected environment were found for this sound by KpA language consultants from INT, therefore, no comparative analysis could be conducted between the production of /ʌə/ by Ach and KpA language consultants. As for Ach [ʌə] (see Appendix P.5.1 and P.5.2), only 4 tokens were measured from one word found as shown in Table 5.15.

Table 5.15: Words to Elicit /ʌə/

No	Words	Gloss	Ach	KpA
1	*dhöe*	clog	✓	
Total number of words			1	0
Total number of tokens			4	0

n.b. ✓ means the group of speakers produced the word.

T-test could not be conducted as the sample for Ach [ʌə] was n<30. However, Figure 5.42 illustrates the movement of *dhöe* in the vowel space, and similar to the findings from WE (see 5.2.3.5); INT also shows that its trajectory moves towards the back of the vowel space instead of to the center, suggesting [ʌu]. Therefore, Ach language consultants produced this diphthong similarly in both contexts.

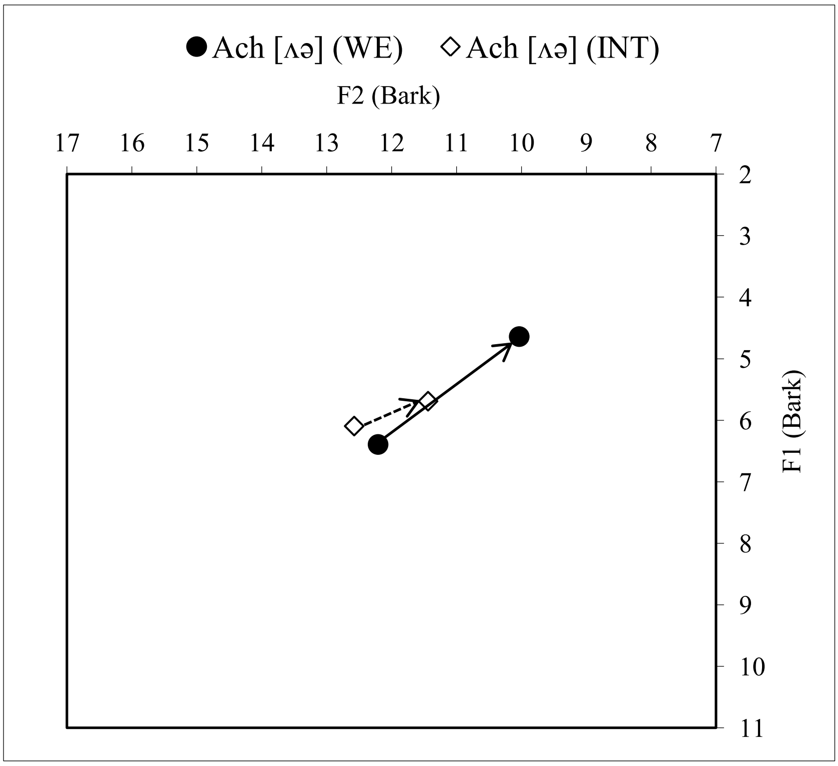


Figure 5.42: Trajectories of Ach [ʌə] from WE and INT
n.b. /ʌə/ is realized as [ʌu] by Ach language consultants in both speaking contexts.

5.3.3.6 The production of /ɔə/

From INT, 11 words were selected to extract /ɔə/ as shown in Table 5.16, with 61 tokens from Ach language consultants (see Appendix P.6.1 and P.6.2) and 58 tokens from KpA language consultants (see Appendix Q.6.1 and Q.6.2).

Table 5.16: Words to Elicit /ɔə/

No	Words	Gloss	Ach	KpA
1	*ad**oe***	younger sibling	✓	✓
2	*as**oe***	meat, filling, contents	✓	✓
3	*beus**oe***	iron		✓
4	*dud**oe**/lud**oe***	finally, at last	✓	✓
5	*gant**oe***	change	✓	
6	*lak**oe***	husband	✓	
7	*lump**oe***	dream	✓	
8	*pas**oe***	insert, fill in	✓	
9	*puj**oe***	praise		✓
10	***soe***	who	✓	✓
11	***toe***	near	✓	✓
Total number of words			9	7
Total number of tokens			61	58

n.b. ✓ means the group of speakers produced the word.

The larger F2 ROC average value from KpA [ɔə] implies that it was produced with greater diphthongal movement compared to Ach [ɔə] as shown in Figure 5.43. However, no significant differences were found in the F1 and F2 ROC average values between Ach [ɔə] and KpA [ɔə] (F1: $t(117)=1.5$, $p=0.068$; F2: $t(117)=3.02$, $p=0.002$). Nonetheless, Figure 5.43 shows that for Ach [ɔə] very small movement is seen to be moving towards the back of the vowel space as indicated in WE (see 5.2.3.6), suggesting [ɔu]. Furthermore, previous findings from WE also showed that KpA [ɔə] moved towards the back of the vowels space suggesting [ɔo], however, findings from INT showed that its trajectory did move towards the center of the vowel space even though the movement is extremely small. This suggests that [ɔə] is maintained in INT by these language consultants.

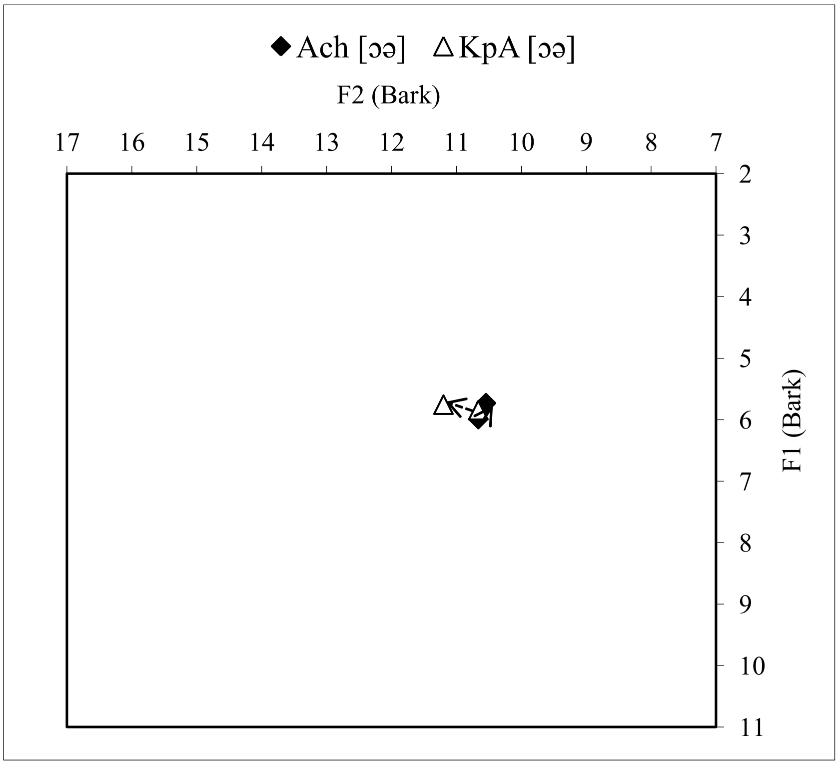


Figure 5.43: Trajectories of Ach [ɔə] and KpA [ɔə] from INT
n.b. /ɔə/ is realized closer to [ɔu] by Ach language consultants.

Figure 5.44 shows the trajectory of Ach [ɔə] from WE and INT and both show that the diphthong production is moving towards the back of the vowel space, suggesting [ɔu]. Although the trajectory in WE shows more movement than INT, t-tests conducted showed that there were no significant differences in the F1 and F2 ROC average values (F1: t(89)=0.87, p=0.193; F2: t(89)=0.97, p=0.167), suggesting that this diphthong was produced similarly in both speaking contexts by Ach language consultants.

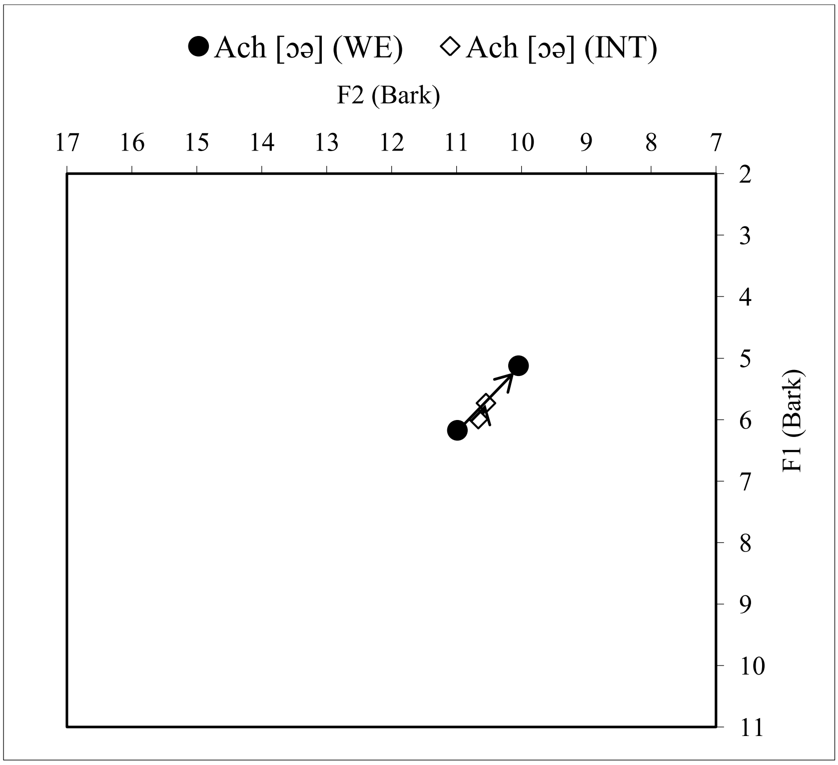


Figure 5.44: Trajectories Ach [ɔə] from WE and INT
n.b. /ɔə/ is realized closer to [ɔu] by Ach language consultants in both speaking contexts.

Figure 5.45 demonstrates the trajectories of KpA [ɔə] from WE and INT. The trajectory from WE shows that [ɔə] is also moving towards the back of the vowel space suggesting [ɔo]; however, the trajectory in INT shows movement towards the center, instead. This was confirmed by t-tests between the two peaking contexts, where no significant differences was found in the F1 ROC average values (t(86)=2.65, p=0.005), but a significant difference was found in the F2 ROC average values (t(86)=4.14, p<.0001). In general, it can be assumed that KpA language consultants maintained /ɔə/ in their Acehnese.

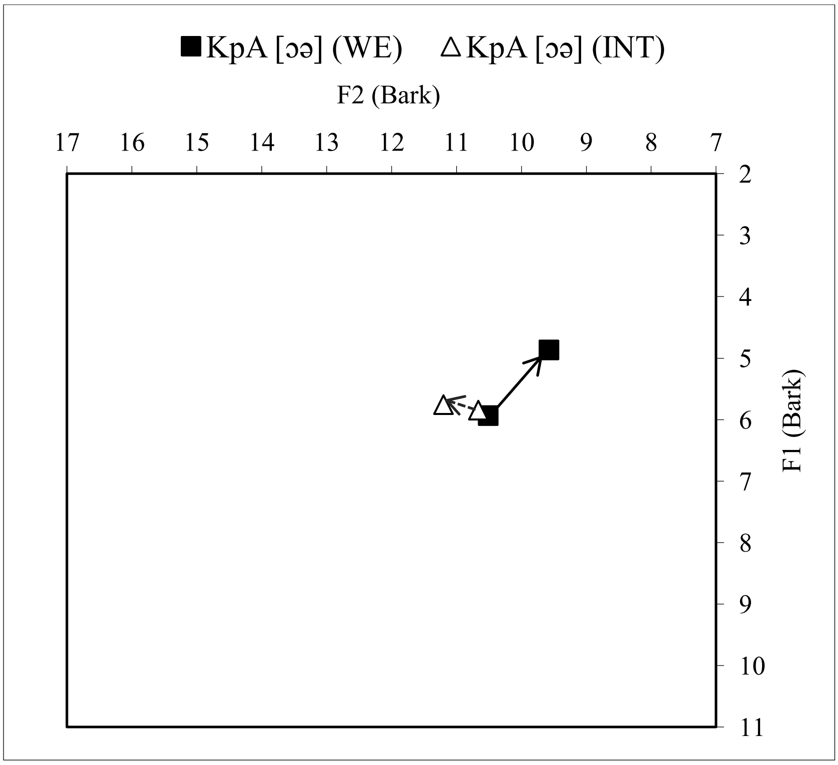


Figure 5.45: Trajectories of KpA [ɔə] from WE and INT

5.3.3.7 The production of /ui/

From INT, only one token was found each by Ach language consultant (see Appendix P.7.1 and P.7.2) and KpA language consultant (see Appendix Q.7.1 and Q.7.2). This is as shown in Table 5.17.

Table 5.17: Words to Elicit /ui/

No	Words	Gloss	Ach	KpA
1	*ap**ui***	fire		✓
2	*ph**ui***	light weight	✓	
Total number words			1	1
Total number of tokens			1	1

n.b. ✓ means the group of speakers produced the word.

A t-test was not conducted between Ach [ui] and KpA [ui] as each had only one token for this sound (or n<30). However, the larger F2 ROC value from KpA [ui] implies that it was produced with a more diphthongal movement compared to Ach [ui] as shown in Figure 5.46.

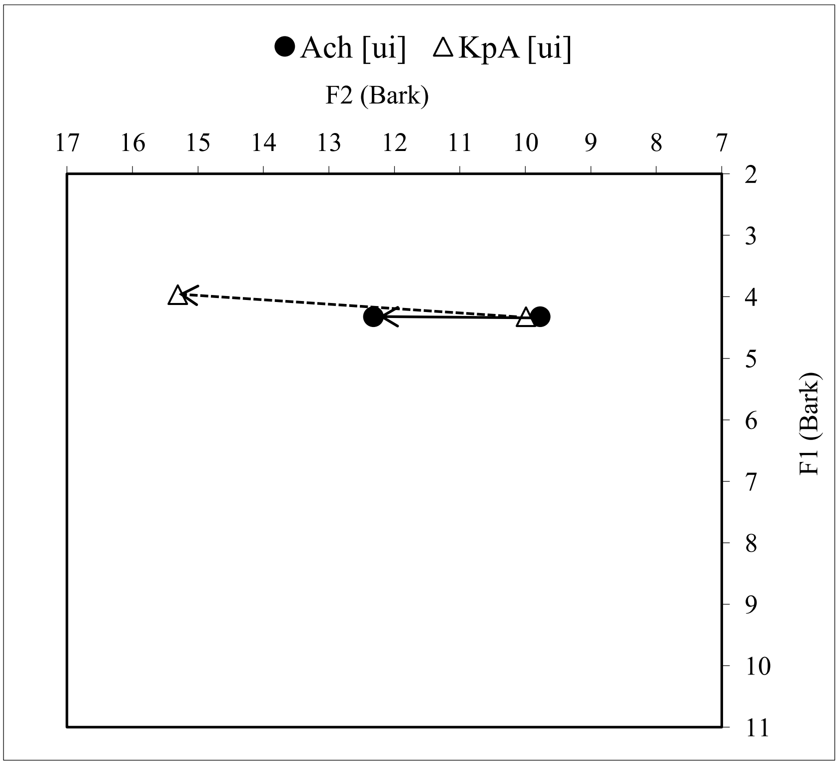


Figure 5.46: Trajectories of Ach [ui] and KpA [ui] from INT

The trajectories of Ach [ui] from WE and INT is shown in Figure 5.47. Even though the trajectory in WE shows more movement than INT, thus, t-tests between both speaking contexts showed that there were no significant differences in the F1 and F2 ROC average values (F1: (t(29)=0.01, p=0.496; F2: t(29)=0.01, p=0.496), suggesting similar [ui] production.

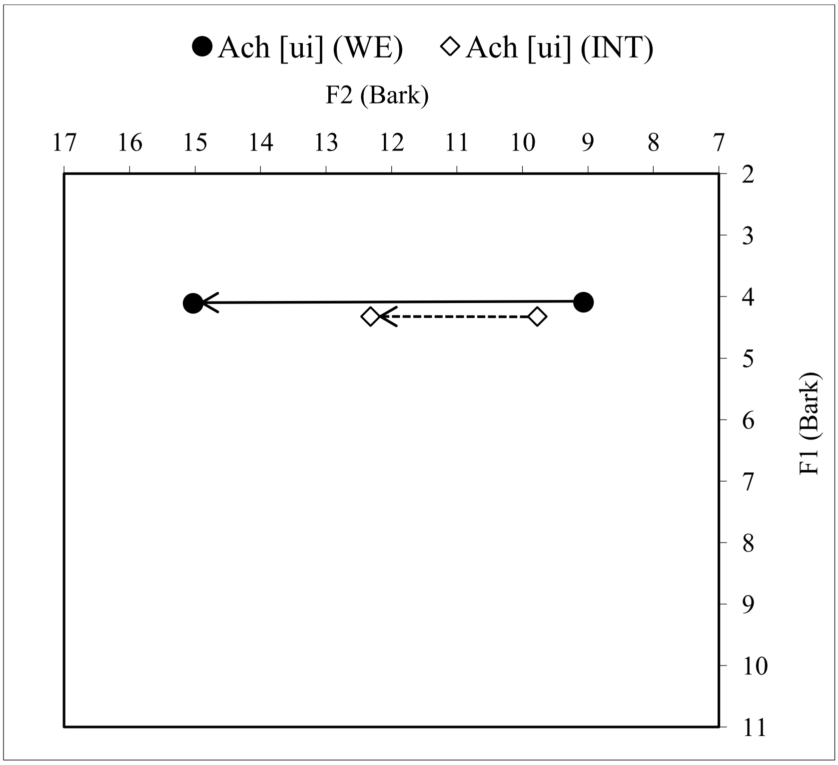


Figure 5.47: Trajectories Ach /ui/ from WE and INT

T-tests between KpA [ui] from WE and INT showed that there was no significant difference in the F1 ROC average values (t(29)=2.06, p=0.024), thus, a significant difference in the F2 ROC average values (t(29)=5.96, p<.0001). This suggests that [ui] from WE shows more movement than INT as demonstrated in Figure 5.48. Thus, the results from INT must be treated with caution as there was only one token measured from each group of speakers for this speaking context.

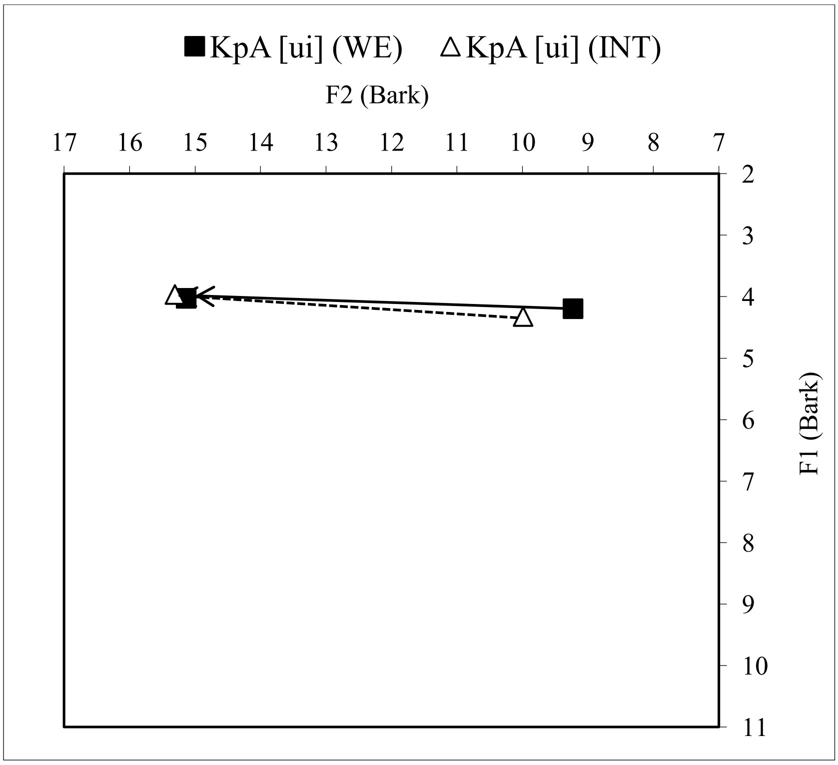


Figure 5.48: Trajectories of KpA [ui] from WE and INT

5.3.3.8 The production of /əi/

From INT, 14 tokens were found for Ach [əi] from one word (see Appendix P.8.1 and P.8.2) and no instances of this sound was found from KpA language consultants as shown in Table 5.18.

Table 5.18: Words to Elicit /əi/ by Ach Language Consultants

No	Words	Gloss
1	***hei***	to call
Total number of words		1
Total number of tokens		14

n.b. ✓ means the group of speakers produced the word.

Similar to WE, Table 5.19 shows that the word *hei* by Ach language consultants in this set of data was also produced as *hôi* with [oi] by KpA language consultants (12 tokens). A t-test was not performed as the sample for KpA *hôi* with [oi] was *n*<30. However,

Figure 5.49 clearly shows the trajectories of this sound production by both language consultants. The onset of this diphthong from Ach language consultants does start at the center position in the vowel space suggesting [əi], whereas its onset by KpA language consultants starts at the back position in the vowel space, suggesting [oi]. Again, the onset F1 and the offset F2 average values for Ach [əi] is 639 Hz and 1724 Hz, which further suggest this particular diphthong production. Whilst the onset F1 and offset F2 average values for KpA [əi] are 553 Hz and 1230 Hz, suggesting [oi]. Once more, INT suggests that KpA language consultants had lost /əi/ in their Acehnese and produced it closer to [oi] instead.

Table 5.19: Words to Elicit /əi/ by KpA language consultants but Produced as [oi]

No	Words	Produced as	Gloss
1	***hei***	***hoi***	to call
Total number of words			1
Total number of tokens			12

n.b. ✓ means the group of speakers produced the word.

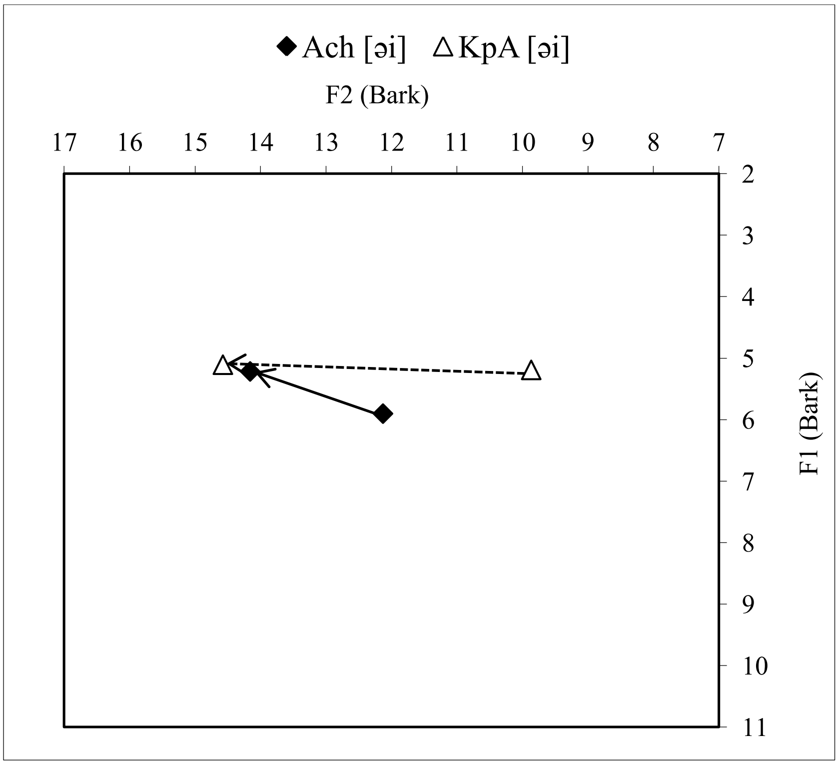


Figure 5.49: Trajectories of Ach [əi] and KpA [əi] from INT
n.b. /əi/ is realized closer to [oi] by KpA language consultants.

The trajectories of Ach [əi] and from WE and INT are further shown in Figure 5.50. A t-test was not conducted as the sample was n<30. Despite the trajectory from WE shows more movement than INT, both movements are rising in the vowel space, suggesting similar productions of [əi].

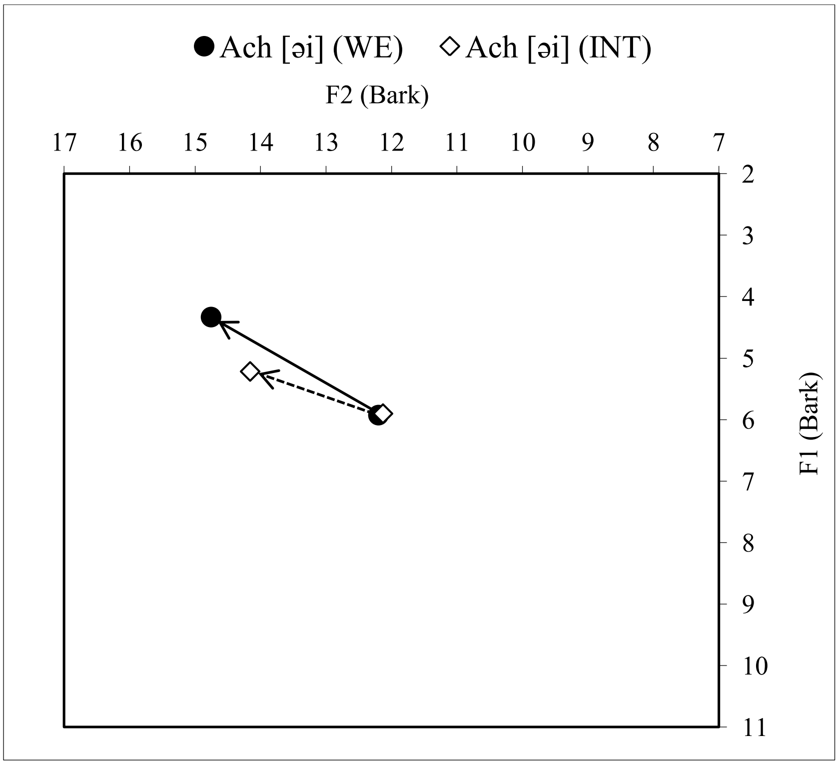


Figure 5.50: Trajectories of Ach [əi] from WE and INT

A t-test for KpA [əi] from WE and INT was not performed as the sample from INT was *n*<30. However, the trajectories of KpA [əi] from both speaking contexts in Figure 5.51 show that both have onset at the back position in the vowel space and offset towards the front position, suggesting [oi]. The movement of [oi] is seen to be more from WE than INT.

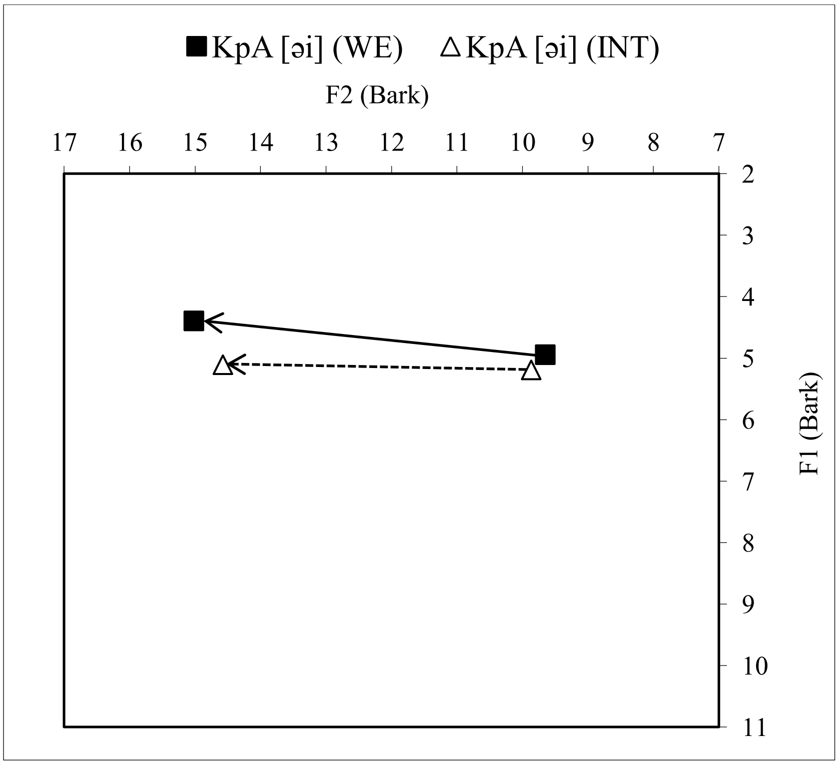


Figure 5.51: Trajectories KpA [əi] from WE and INT
n.b. /əi/ is realized closer to [oi] by KpA language consultants.

5.3.3.9 The production of /oi/

From INT, a number of 8 tokens of Ach [oi] (see Appendix P.9.1 and P.9.2) and 29 tokens of KpA /oi/ (see Appendix Q.9.1 and Q.9.2) were extracted from the words shown in Table 5.20. As n<30 for this sound from both group of speakers in INT, therefore, no t-test was performed.

Table 5.20: Words to Elicit /oi/

No	Words	Gloss	Ach	KpA
1	*beut**ôi***	correct	✓	✓
2	*gh**ôi***	to mix		✓
3	*h**ôi***	to call		✓
4	*kump**ôi***	collect	✓	✓
5	*numb**ôi***	number		✓
Total number of words			2	5
Total number of tokens			8	29

n.b. ✓ means the group of speakers produced the word.

The smaller F1 ROC average value of KpA [oi] suggests that it was produced with a lesser movement compared to Ach [oi]. Figure 5.52 shows the parallel trajectories of this diphthong by both groups of language consultants for [oi] production.

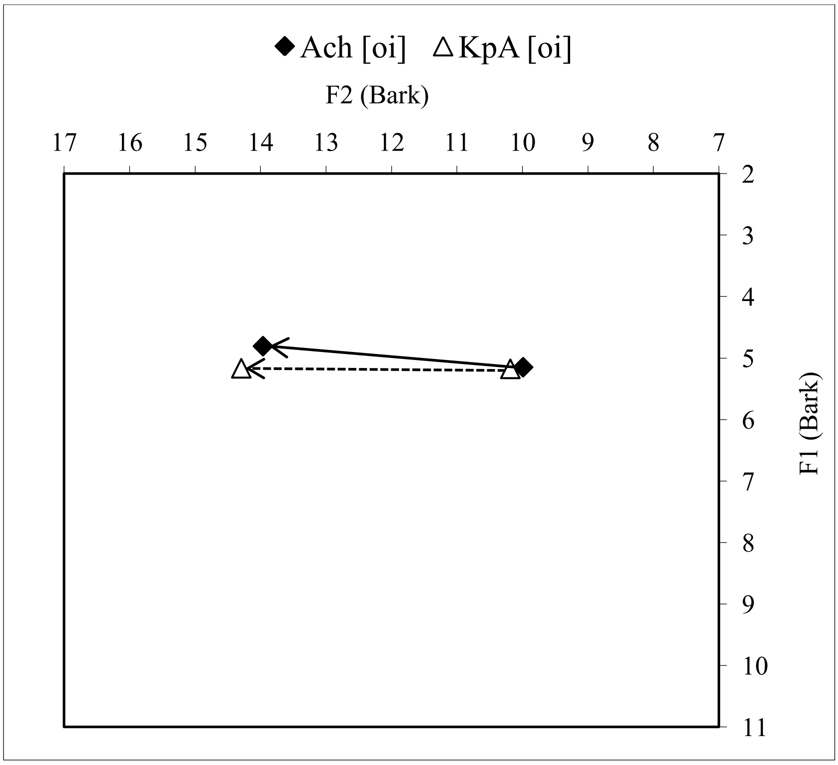


Figure 5.52: Trajectories of Ach [oi] and KpA [oi] from INT

Moreover, Figure 5.53 shows the trajectories of Ach [oi] from WE and INT. From here, it is seen that the production of this diphthong was produced with more movement from WE compared to INT.

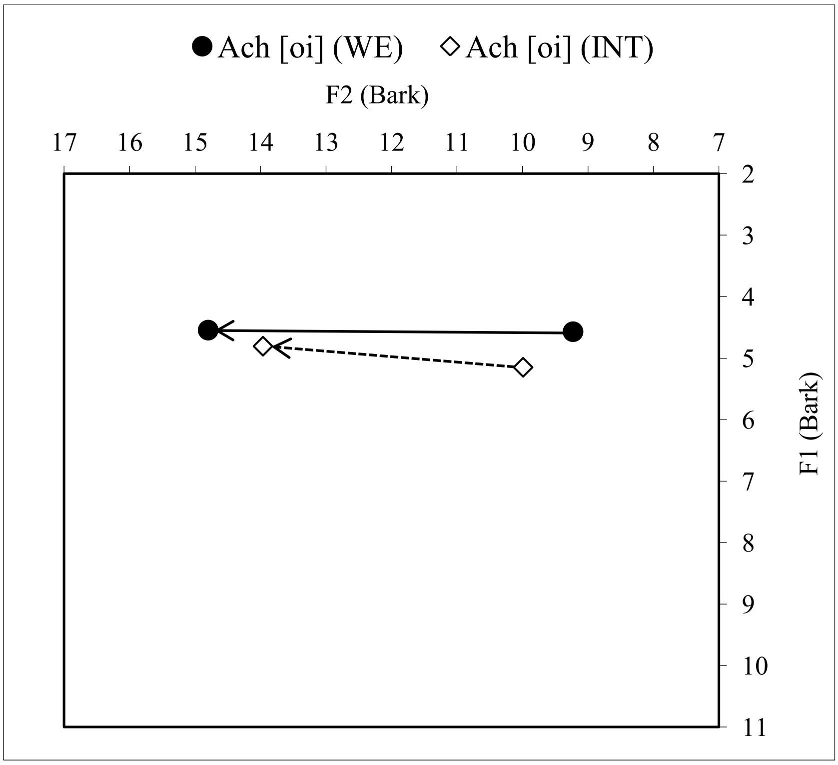


Figure 5.53: Trajectories of Ach [oi] from WE and INT

KpA [oi] from WE also showed more movement than INT as demonstrated in Figure 5.54.

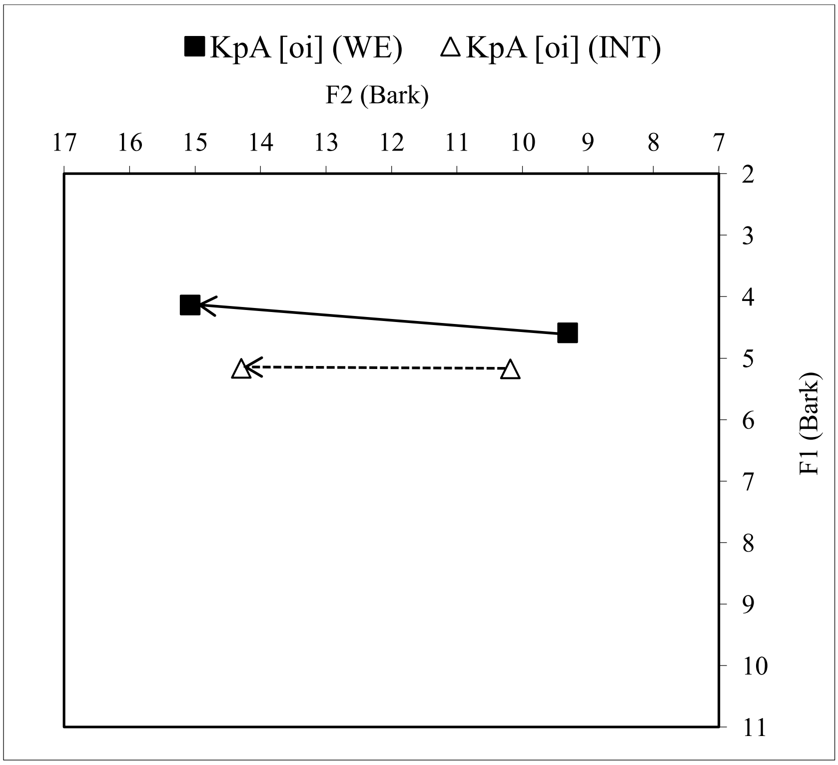


Figure 5.54: Trajectories of KpA /oi/ from WE and INT

5.3.3.10 The production of /ʌi/

Unfortunately, no instances of /ʌi/ were found in INT, both from Ach and KpA language consultants. Therefore, further assessment on this sound could not be conducted on this set of data.

5.3.3.11 The production of /ɔi/

No instances of /ɔi/ were found for both Ach and KpA language consultants in INT. Therefore, further examination on this sound could not be conducted in the natural speaking context.

5.3.3.12 The production of /ai/

A number of 13 words were found to extract /ai/ from INT as shown in Table 5.21, with 104 tokens from Ach language consultants (see Appendix P.12.1 and P.12.2) and 97 tokens from KpA language consultants (see Appendix Q.12.1 and Q.12.2).

Table 5.21: Words to Elicit /ai/

No	Words	Gloss	Ach	KpA
1	*ak**ai***	mind	✓	
2	*and**ai***	if	✓	
3	*as**ai***	origin, as long as, just so	✓	✓
4	*bant**ai***	pillow	✓	✓
5	*beuk**ai***	stock		✓
6	*gat**ai***	itch, itchy	✓	
7	*h**ai***	hey	✓	✓
8	*kap**ai***	ship, plane	✓	✓
9	*meuningg**ai***	died, dead	✓	✓
10	*padah**ai***	actually	✓	
11	*pas**ai***	because		✓
12	*sag**ai***	only		✓
13	*tingg**ai***	live	✓	✓
Total number of words			10	9
Total number of tokens			104	97

n.b. ✓ means the group of speakers produced the word.

On the production of /ai/ from both groups of language consultants, a significant difference was found in the F1 ROC average values (t(199)=6.28, p<.0001), but no significant differences in the F2 ROC average values (t(199)=0.15, p=0.440). Consequently, the smaller F1 and F2 ROC average values of KpA [ai] indicate that it was produced with lesser movement compared to Ach [ai] and this can be seen in their trajectories in Figure 5.55.

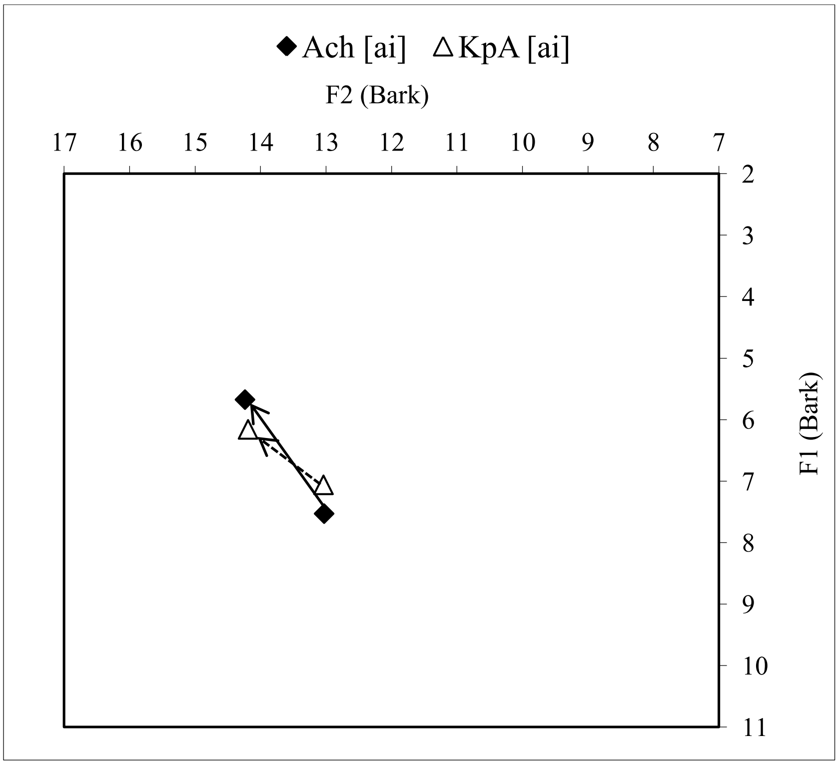


Figure 5.55: Trajectories of Ach [ai] and KpA [ai] from INT

Figure 5.56 illustrates that the trajectory of Ach [ai] from WE shows more movement than INT, thus, t-tests showed no significant differences in the F1 and F2 ROC values (F1: $t(132)=2.6$, $p=0.005$; F2: $t(132)=1.8$, $p=0.037$), therefore, [ai] was produced similarly in both speaking contexts by Ach language consultants.

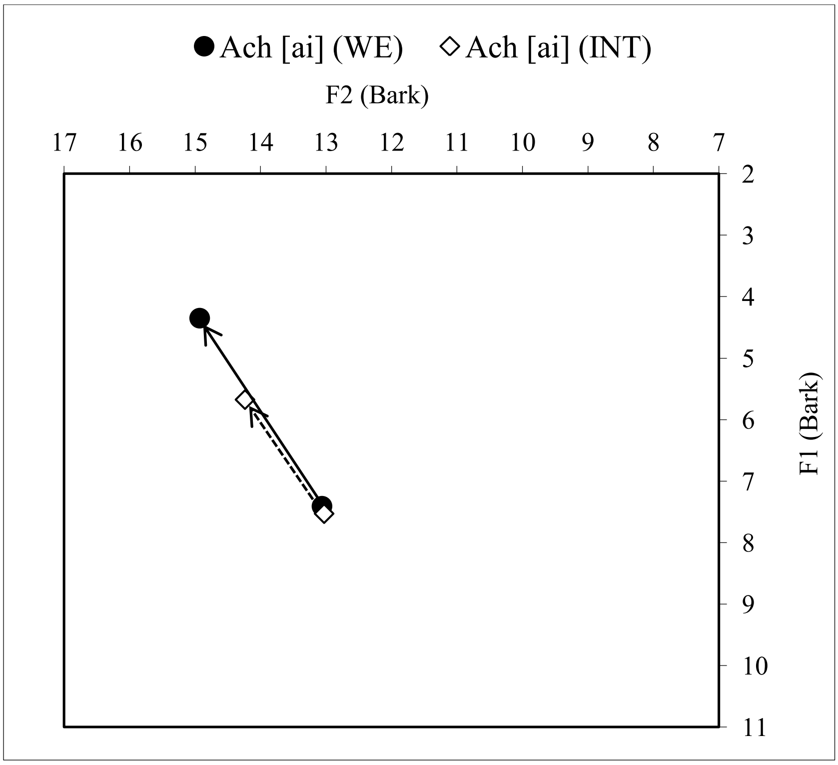


Figure 5.56: Trajectories Ach [ai] from WE and INT

Figure 5.57 demonstrates that KpA [ai] from WE shows more movement as well compared to INT, however, t-tests results showed that there were no significant differences in the F1 and F2 ROC average values (F1: t(125)=2.08; p=0.020; F2: t(125)=1.8, p=0.037) and so [ai] were produced similarly in both speaking contexts by KpA language consultants.

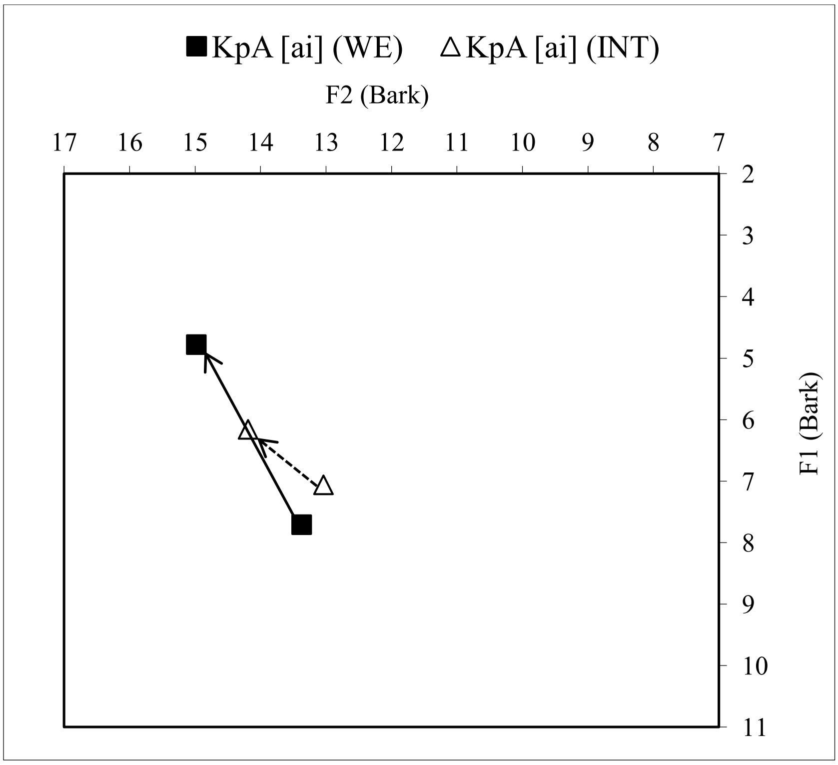


Figure 5.57: Trajectories KpA [ai] from WE and INT

5.4 Conclusion

The results showed that for Ach language consultants, the diphthongs /ʌə/ and /ɔə/ from WE and INT both displayed trajectories that move to high back positions, suggesting vowels akin to [ʌu] and [ɔu]. The other diphthongs were generally maintained, namely /iə/, /ɛə/, /ɯə/, /uə/, /ui/, /əi/, /oi/, /ʌi/, /ɔi/ and /ai/.

For KpA language consultants, there were only three diphthongs that appeared to be maintained, which were /ui/, /oi/ and /ai/. Furthermore, INT had validated WE findings of the monophthongisation of the onset segment involved from two diphthongs, /iə/ and /ɛə/, to be realized as monophthongs [i] and [ɛ]. The diphthongs /ɯə/ and /uə/ were realized differently in both speaking context, where /ɯə/ was closer to /ɯɨ/ in WE but realized as a monophthong /ɯ/ in INT, whilst /uə/ was closer to /uɯ/ in WE but realized as a monophthong /u/ in INT. Similar to WE, all instances of /əi/ in *hei* in INT were also realized as [oi]. In WE, the diphthongs in the words *dhöe* and *toe* were realized as [ɔo], thus, in INT the sound /ɔə/ was conserved. In WE, the diphthong in the word *lagöina* was realized as [ɔe], and the diphthong in the word *poih* as was realized [oe]. Nevertheless, no further examination could be conducted on the production of /ʌə/, /ʌi/ and /ɔi/ as they were absent in INT in the selected environment for this study.

Furthermore, t-tests conducted between Ach and KpA centering diphthongs from WE showed that no significant differences were found in the F1 ROC average values ($t(5)=1.43$, $p=0.106$) and in the F2 ROC average values ($t(5)=1.24$, $p=0.135$). Next, t-tests conducted between Ach and KpA rising diphthongs from WE also showed that no significant differences were found in the F1 ROC average values ($t(5)=1.31$, $p=0.124$) and in the F2 ROC average values ($t(5)=1.56$, $p=0.090$). This indicates that the rates of change of the diphthongs between the two groups of language consultants from this speaking context are similar.

T-tests were further conducted between Ach and KpA centering diphthongs from INT. The results showed that no significant differences were found in the F1 ROC average values ($t(5)=0.41$, $p=0.350$) and in the F2 ROC average values ($t(5)=1.92$, $p=0.057$). Then, t-tests conducted between Ach and KpA rising diphthongs from INT also showed that no significant differences were found in the F1 ROC average values ($t(5)=1.31$, $p=0.124$) and in the F2 ROC average values ($t(5)=1.16$, $p=0.150$). This indicates that the rates of change of the diphthongs between the two groups of language consultants from this speaking context are similar.

CHAPTER 6 : INFLUENCE OF STANDARD MALAY AND KEDAH DIALECT VOWELS ON ACEHNESE VOWELS IN KAMPUNG ACEH

6.1 Introduction

The previous chapter presented the characteristics of Acehnese oral vowels spoken by speakers in Ach and present day Acehnese descents in KpA. This chapter presents findings from the SM and KD vowel measurements and examines the similarities and differences between them. It further presents the possible influences from SM and KD vowels towards Acehnese vowels produced by speakers in KpA. Lastly, this chapter discusses the possible relationship between identity and the maintenance of Acehnese sounds in KpA.

6.2 The Quality of SM and KD Vowels

In total, 198 tokens were measured to study SM and KD vowels. As there was n<30 for every vowel, no t-test was conducted for the findings of SM and KD vowels.

6.2.1 SM Vowels

There were 90 elicitation tokens for the nine SM vowels; with 54 tokens for six monophthongs and another 27 tokens for three diphthongs.

6.2.1.1 SM Monophthongs

The F1 and F2 average values and durations for the monophthong vowels are presented in Table 6.1. SD in parentheses is also presented. The average values of the monophthongs as produced by every SM language consultant can be found in Appendix R.

Table 6.1: F1 and F2 Average Values, and SD for SM Monophthongs

Vowel	Target Word	Duration (sec)	Ave. F1 and SD (Hz)	Ave. F2 and SD (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
i	*pita*	0.092 (0.02)	428 (18.58)	2703 (90.55)	4.10 (0.17)	14.98 (0.20)
e	*beta*	0.110 (0.01)	567 (18.97)	2417 (122.19)	5.31 (0.16)	14.30 (0.31)
a	*batu*	0.121 (0.02)	948 (32.96)	1706 (39.88)	8.17 (0.11)	12.06 (0.16)
u	*buta*	0.103 (0.01)	468 (25.16)	1028 (50.41)	4.46 (0.22)	8.69 (0.31)
o	*kota*	0.130 (0.02)	579 (34.51)	1182 (24.99)	5.41 (0.29)	9.60 (0.29)
ə*	*peta*	0.072 (0.02)	583 (28.14)	1889 (91.15)	5.44 (0.23)	12.73 (0.31)

n. b. *central vowel

The placement of vowels in the vowel space for SM monophthongs can be seen in Figure 6.1.

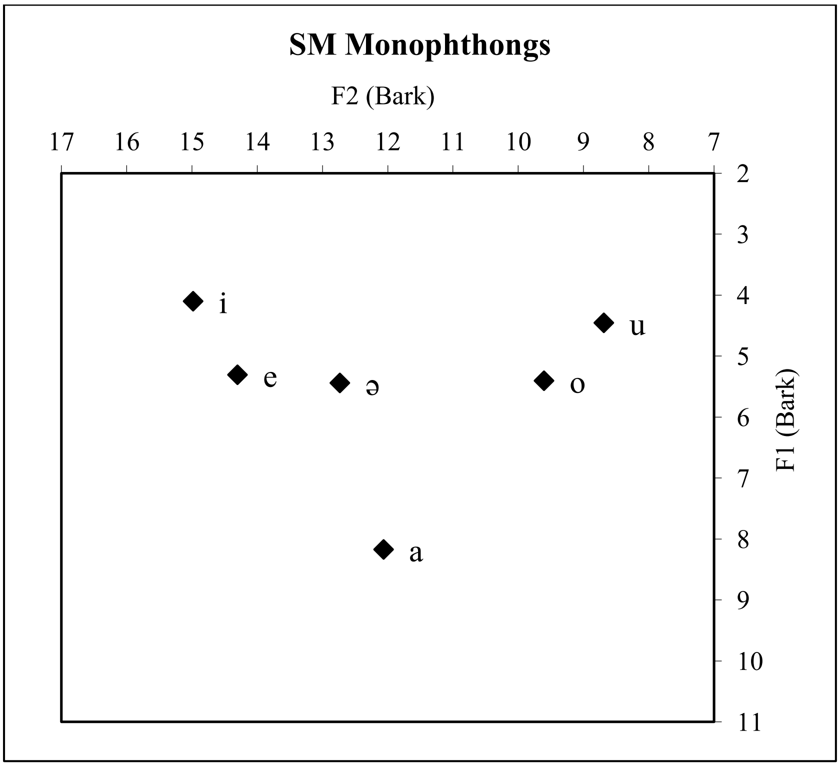


Figure 6.1: Plot of formant average values for SM monophthongs

From Figure 6.1, the positions of [i] and [e] can be seen as front vowels, [ə] and [a] as central vowels, and [u] and [o] as back vowels. These are similar to the descriptions of these vowels in previous studies (e.g. Asmah, 1993; Chaiyanara, 2001; Indirawati & Mardian, 2006; Teoh, 1994; Yunus 1980). Table 6.1 provides the measurements for these vowels to further illustrate their qualities. The sound [i] has smaller F1 average value but bigger F2 average value compared to the other front vowel [e], therefore, it was produced higher and more fronted than [e]. This is clearly illustrated in Figure 6.1. Similarly, [ə] as a central vowel also has smaller F1 average value but bigger F2 average value compared to [a], and its position is also higher and more fronted than [a] in the center of the vowel space. Finally, [u] was produced with the smallest F1 and F2 average values compared to the other back vowel [o], therefore, it is positioned higher and more back than [o] in the vowel space. The following Figure 6.2 shows the scatter plot of these vowels as produced by the language consultants as front, central and back vowels. In general, the language consultants clearly maintained the distinction between these vowels in the vowel space.

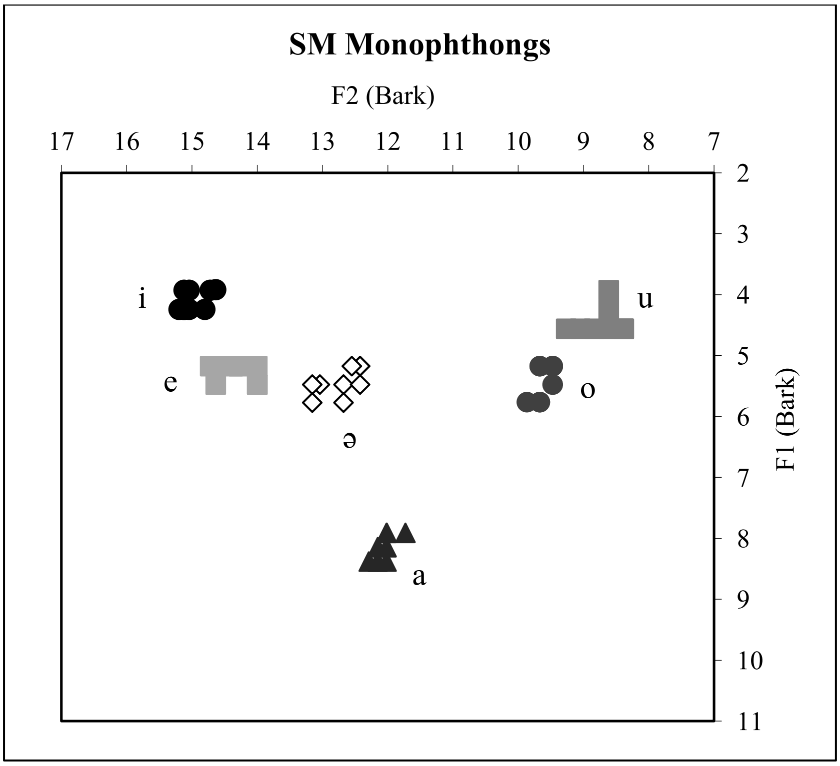


Figure 6.2: Scatter plot of SM monophthongs

Referring to studies by Mardian (2005) and Shaharina and Shahidi (2012) on Malay vowels, different qualities were found in their findings compared to the findings presented in this present study. This can be seen in the plot of their SM monophthongs with those in this study as shown in Figure 6.3. In Figure 6.3, Shaharina and Shahidi's vowels are only represented by female speakers as this study was based on female language consultants.

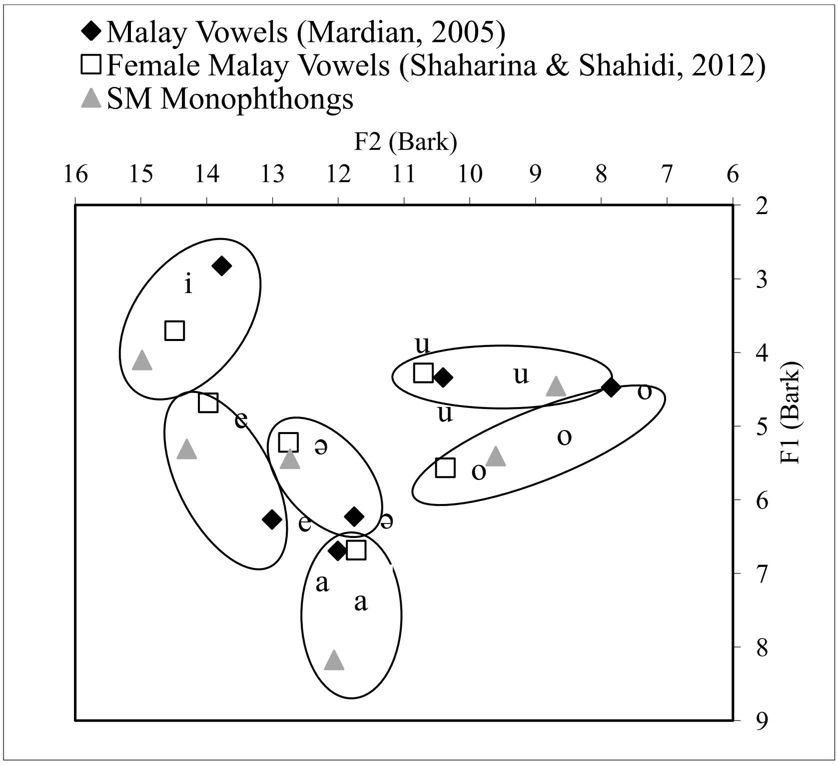


Figure 6.3: Plot of SM monophthongs from Mardian (2005), Shaharina and Shahidi (2012) and this present study

Based on Figure 6.3, it is seen that speakers from Mardian's (2005) and Shaharina and Shahidi's (2012) studies compared to the present one produced the vowels [i] and [a] higher. Thus, for [e] and [ə], both were produced higher by the speakers from Shaharina and Shahidi and lower by Mardian's. For [u], the language consultants in this study produced it more back and slightly lower than the other two studies. Lastly, [o] is produced higher by the speaker from Mardian and lower by the speakers from Shaharina and Shahidi compared to this present study. As the number of speakers and also the words used to elicit the vowels from previous studies are unknown, no comparative analysis could be conducted among these studies. Nevertheless, the plot in Figure 6.3 visibly shows that speakers from every study make a distinction among the vowel productions. The different qualities are possibly due to the different words and contexts used to extract the vowels by previous studies compared to this present one.

6.2.1.2 SM Diphthongs

Table 6.2 presents the F1 and F2 ROC average values for each SM diphthong and SD are in parentheses. The average values of the diphthongs as produced by every SM language consultant can be found in Appendix S.

Table 6.2: F1 and F2 ROC Average Values, and SD for SM Diphthongs

Diphthongs	Target Word	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
ai	*lambai*	-2798 (695.25)	6337 (1671.15)
au	*kerbau*	-2301 (500.39)	-2902 (494.68)
oi	*amboi*	-534 (452.54)	12609 (21.23.63)

Based on Table 6.2, the largest F2 ROC average value for [oi] indicates that it was produced with the most movement compared to the other diphthongs: [ai] and [au]. The negative F1 ROC average values for all three diphthongs indicate movements from lower to higher vowels as can be seen in Figure 6.4. The positive F2 ROC average values for [ai] and [oi] indicate their movements towards the front of the vowel space, approximating [i], whilst the negative F2 ROC average value for [au] means movement towards the back of the vowel space, approximating [u]. These descriptions are also similar to the descriptions of these diphthongs in previous studies by Asmah (1993), Indirawati and Mardian (2006) and Teoh (1994). For Figure 6.4, every diphthong average measurement in Bark for SM language consultants are provided in Appendices S.1.1 to S.3.2.

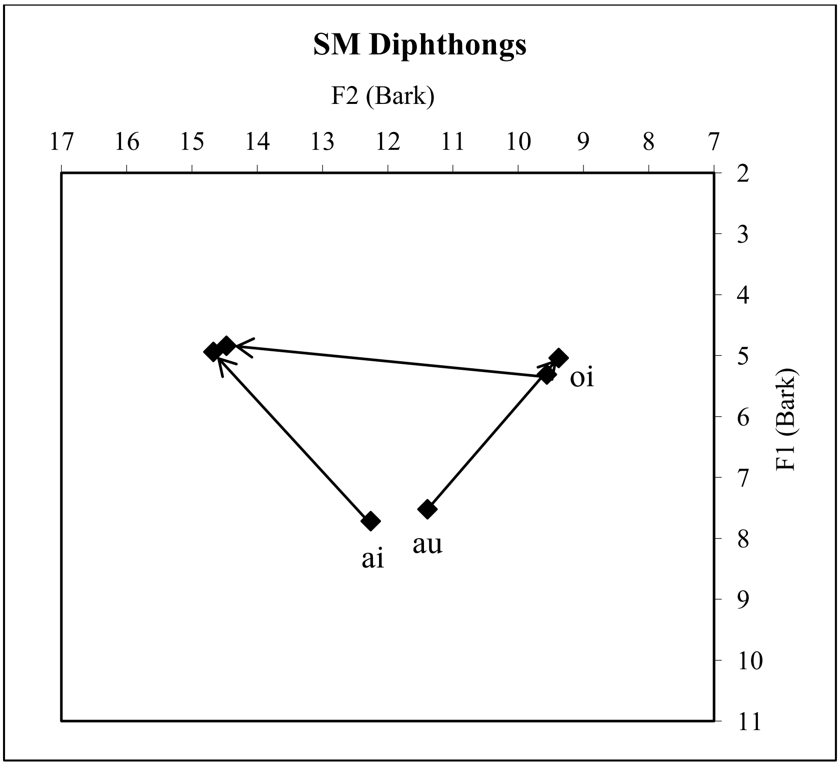


Figure 6.4: Diphthongal movements for SM diphthongs

6.2.2 KD Vowels

For eleven KD vowels, a total of 108 elicitation tokens were measured; with 72 tokens for eight monophthongs and another 36 tokens for four diphthongs. They are explained in the following subsections.

6.2.2.1 KD Monophthongs

The F1 and F2 average values and durations for the monophthong vowels are presented in Table 6.3. SD in are also presented. The average values of monophthongs as produced by every KD language consultant can be found in Appendix T.

Table 6.3: F1 and F2 Average Values, and SD for KD Monophthongs

Vowel	Target Word	Duration (sec)	Ave. F1 and SD (Hz)	Ave. F2 and SD (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
i	*pita*	0.103 (0.03)	404 (37.64)	2782 (120.17)	3.89 (0.34)	15.16 (0.25)
e	*beta*	0.111 (0.01)	516 (25.10)	2576 (67.02)	4.87 (0.22)	14.69 (0.16)
ɛ	*bebeh*	0.122 (0.01)	599 (18.00)	2520 (49.01)	5.58 (0.15)	14.56 (0.12)
a	*batu*	0.143 (0.03)	861 (53.58)	1856 (92.62)	7.58 (0.38)	12.62 (0.33)
u	*buta*	0.102 (0.02)	421 (17.59)	1052 (50.12)	4.03 (0.16)	8.83 (0.31)
o	*kota*	0.151 (0.03)	504 (18.00)	1159 (35.50)	4.77 (0.16)	9.47 (0.20)
ɔ	*bodong*	0.151 (0.02)	595 (15.87)	1186 (66.33)	5.54 (0.13)	9.63 (0.37)
ə*	*peta*	0.073 (0.02)	559 (34.44)	1932 (73.73)	5.24 (0.29)	12.88 (0.25)

n. b. *central vowel

Figure 6.5 further shows the plot of formant average values for KD vowels and illustrates the placement of vowels in the vowel space.

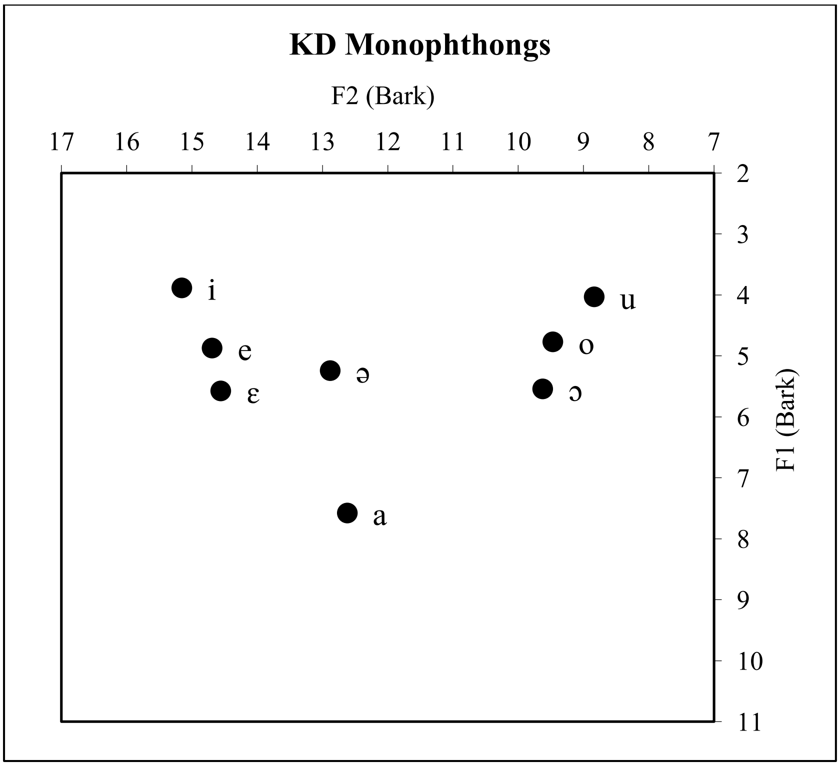


Figure 6.5: Plot of formant average values for KD monophthongs

Figure 6.5 shows that there is a clear distinction of the front, center and back vowels. The front vowels include [i], [e] and [ɛ], the center vowels are [ə] and [a], and the back vowels are [u], [o] and [ɔ]. The positions of these vowels are similar to the descriptions of these vowels in previous studies by Asmah (1993) and Ismail, et al. (2002). Thus, based on the measurements in this acoustic study, the qualities of the vowels are known as shown in Table 6.3. For the front vowels, [i] has a bigger F2 average value compared to [e] and [ɛ], and this is discernible in Figure 6.5 where it is seen to be positioned more fronted compared to the other two front vowels. The sound [ə] has smaller F1 average value but bigger F2 average value compared to [a] and this is shown by its position that is higher and slightly more fronted than [a] in the center of the vowel space. Lastly, [u] was produced with the smallest F1 and F2 average values compared to the other back vowels [u] and [ɔ] and this is illustrated by its position that is further back than the other back vowels in the vowel space. The following Figure 6.6 further shows the scatter plot of these vowels produced by the language consultants as front, central and back vowels.

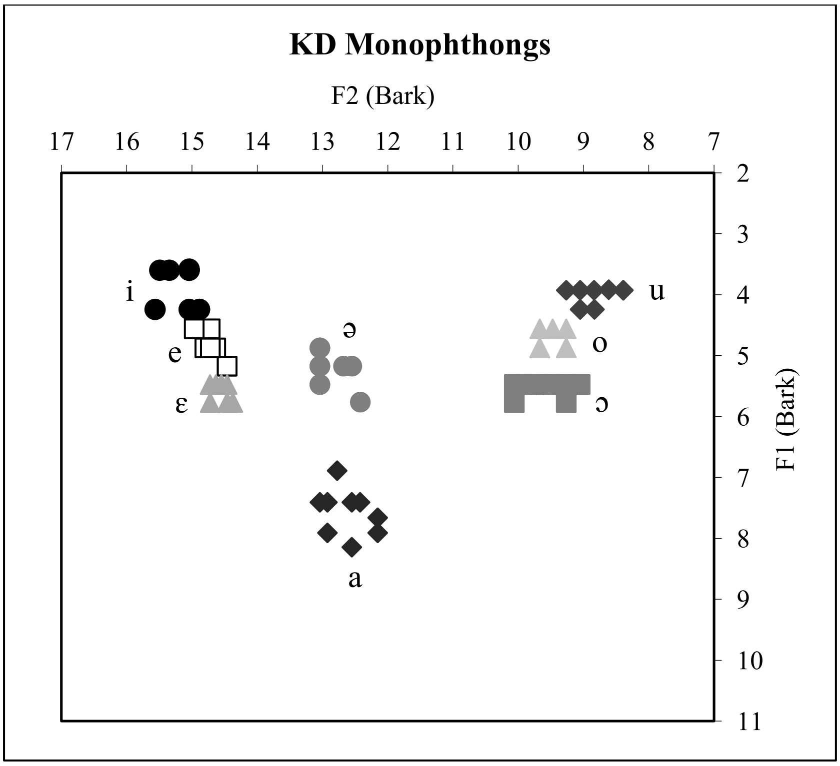


Figure 6.6: Scatter plot of KD monophthongs

The scatter plot for [i], [e] and [ɛ] presented in Figure 6.6 shows that there is variability in the way that these vowels were produced by the language consultants. Some tokens of [i] were produced very close to [e] and some tokens of [e] were also produced near to [ɛ]. However, the standard deviations (see Table 6.3) shows that this variability is not prominent because each language consultant tended to maintain the distinction between these three vowels as shown in Figure 6.7, which presents the production of front vowels by KD1.

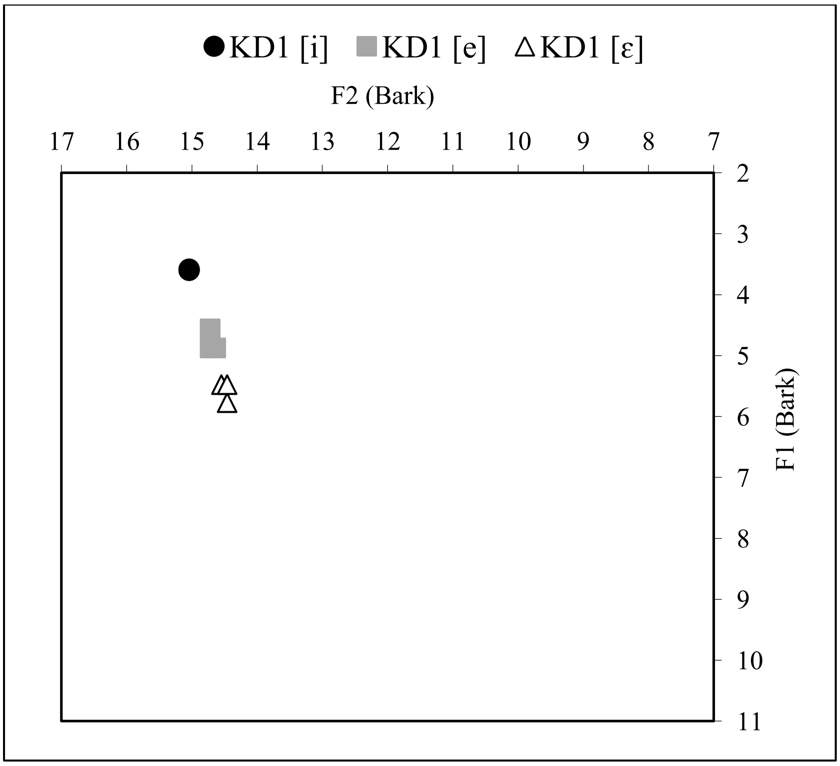


Figure 6.7: Scatter plot of [i], [e] and [ɛ] for KD1

6.2.2.2 KD Diphthongs

The F1 and F2 ROC average values for each KD diphthong and SD in parentheses are presented in Table 6.4. The average values of the diphthongs as produced by every KD language consultant can be found in Appendix U.

Table 6.4: F1 and F2 ROC Average Values, and SD for KD Diphthongs

Diphthongs	Target Word	F1 ROC (Hz/sec)	F2 ROC (Hz/sec)
ai	*lambai*	-2642 (1065.91)	5485 (2316.05)
au	*kerbau*	-2332 (629.01)	-3852 (1509.29)
ui	*bui*	-54 (258.89)	7533 (2306.94)
oi	*amboi*	-391 (446.06)	9152 (3703.70)

In Table 6.4, the largest F2 ROC average value is found in [oi], this means that is was produced with the most movement compared to the other diphthongs: [ai], [au] and [ui]. The smallest F1 ROC average value for [ui] indicated a lack of change in vowel height for this diphthong. The positive F2 ROC average values for [ai], [ui] and [oi] reflect the trajectories from the back to the front of the vowel space, approximating [i] as shown in Figure 6.8. Whilst the negative F2 ROC average value for [au] represents its trajectory to the back of the vowel space, approximating [u]. These descriptions are also akin to the descriptions of these diphthongs in previous auditory studies by Asmah (1993) and Ismail, et al. (2002). For Figure 6.8, every diphthong average measurement in Bark for KD language consultants are provided in Appendices U.1.1 to U.4.2.

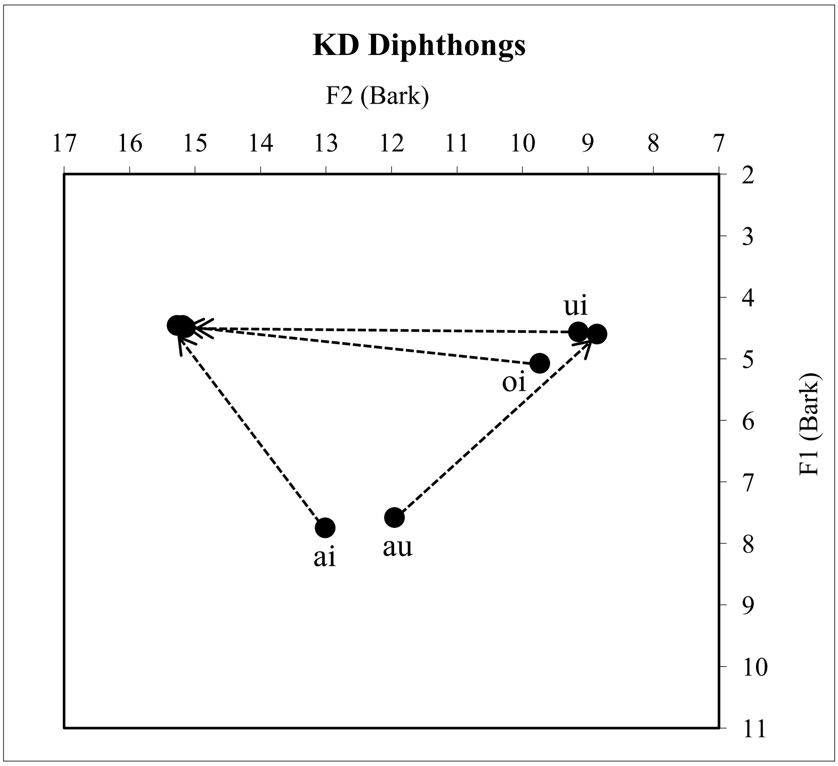


Figure 6.8: Diphthongal movements for KD diphthongs

6.3 Influences from SM and KD Vowels

This section further presents the possible influences of SM and KD vowel production towards the production of Acehnese vowels produced by KpA language consultants. To do so, the similarities and differences between the production of Acehnese vowels in KpA with SM and KD vowels are presented. It also looks back at the findings of Acehnese vowels in Ach in CHAPTER 4 and CHAPTER 5 and relates them with the findings presented in the following sections.

6.3.1 Comparison of Monophthongs

This section presents the comparison of monophthongs from KpA, Ach, SM and KD language consultants. Comparison with Ach language consultants was also conducted to further study their similarities and differences in vowel productions. The comparison of vowels [i], [e], [ə], [a], [u] and [o] were conducted between Acehnese in Ach and KpA, SM and KD because these vowels are present in their vowel inventories. Whilst [ɛ] and [ɔ] were only conducted between Acehnese vowels in Ach and KpA and KD vowels as SM do not have these two vowels in its inventory. The vowels [ɯ] and [ʌ] were excluded as these vowels are only realized in Acehnese, but not in SM and KD. The findings from WE are written as Ach-WE for Ach language consultants and KpA-WE for KpA language consultants. Similarly, the findings from INT are written as Ach-INT for Ach language consultants and KpA-INT for KpA language consultants.

6.3.1.1 The vowel /i/

All four groups of KpA, Ach SM and KD language consultants produced /i/ in their speech. To better see the [i] production from all language consultants, Table 6.5 provides the average values of [i] produced the four groups of language consultants. The average values of [i] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.5: Measurements of /i/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark)
Ach-WE	0.155 (0.05)	429 (27.73)	2653 (130.08)	4.11 (0.25)	14.87 (0.29)
KpA-WE	0.142 (0.03)	424 (21.30)	2775 (126.67)	4.07 (0.19)	15.14 (0.26)
Ach-INT	0.094 (0.05)	489 (42.83)	2663 (167.68)	4.63 (0.38)	14.88 (0.38)
KpA-INT	0.098 (0.05)	490 (33.25)	2707 (160.07)	4.65 (0.29)	14.99 (0.35)
SM	0.092 (0.02)	428 (18.58)	2703 (90.55)	4.10 (0.17)	14.98 (0.20)
KD	0.103 (0.03)	404 (37.64)	2782 (120.17)	3.89 (0.34)	15.16 (0.25)

n.b. Standard Deviations are in parentheses.

From Table 6.5, [i] from Ach-WE was produced with the longest duration at 0.155 sec compared to the other groups of language consultants, whereas SM language consultants produced it with the shortest duration at 0.092 sec. We start first on the comparison of [i] between KpA, SM and KD language consultants. The distribution of [i] from KpA-WE, KpA-INT, SM and KD are shown in Figure 6.9. It shows overlap between the vowels produced by these three groups of language consultants, meaning that they produced [i] similarly.

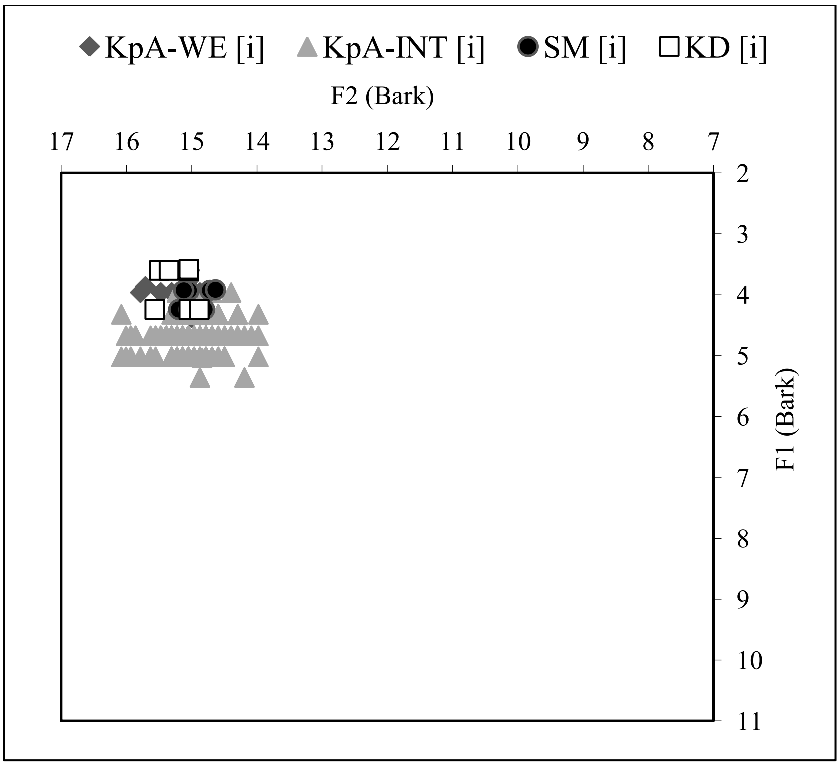


Figure 6.9: Distribution of [i] from KpA-WE, KpA-INT, SM and KD

Next, we compare the production of [i] by all four groups of language consultants. Refer to the findings in 4.2.3.1 and 4.3.3.1, [i] from Ach-WE and KpA-WE were produced similarly. Figure 6.10 and Figure 6.11 further illustrate how the tokens of [i] by Ach and KpA language consultants from WE and INT, SM and KD language consultants overlap and show a lack of contrast, therefore, they produced this sound similarly.

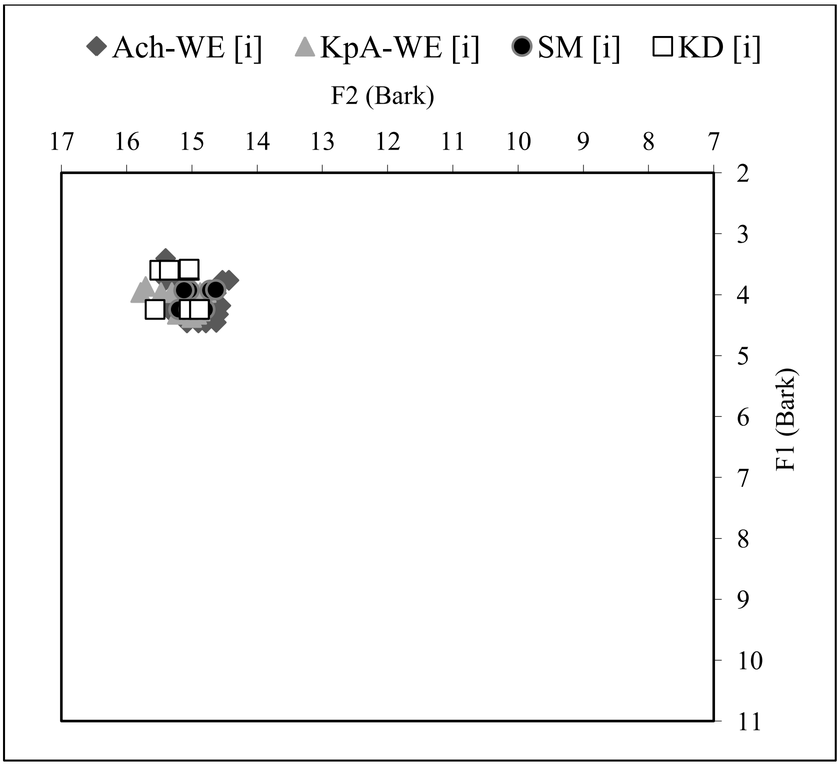


Figure 6.10: Distribution of [i] from Ach-WE, KpA-WE, SM and KD

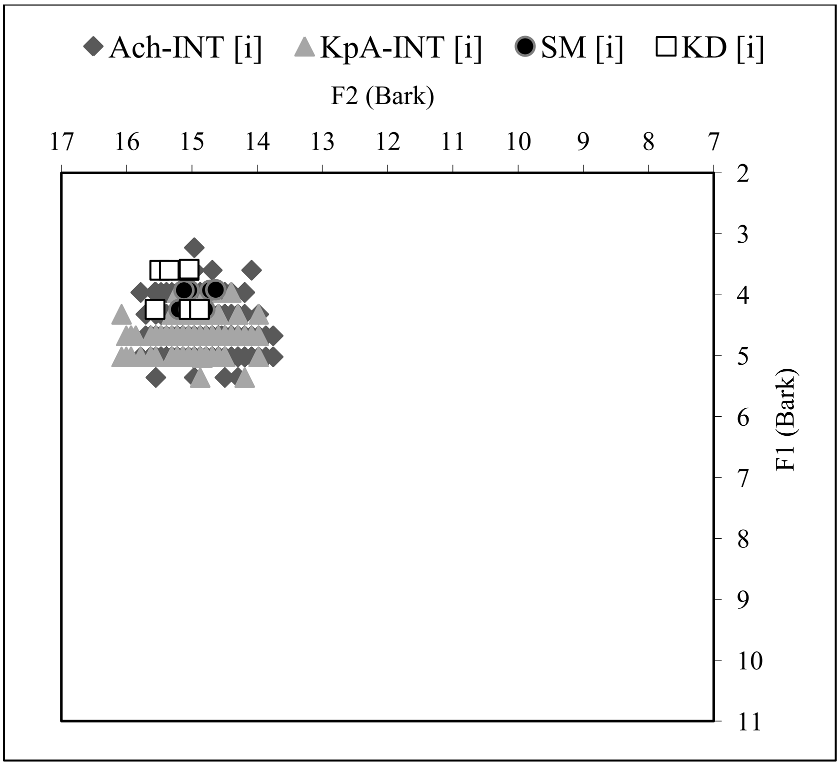


Figure 6.11: Distribution of [i] from Ach-INT, KpA-INT, SM and KD

6.3.1.2 The vowel /e/

The sound /e/ was also produced by KpA, Ach, SM and KD language consultants. Table 6.6 provides the average values of [e] production from all four groups of language consultants. The average values of [e] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.6: Measurements of /e/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.142 (0.04)	504 (49.31)	2518 (112.30)	4.77 (0.43)	14.55 (0.27)
KpA-WE	0.164 (0.03)	486 (28.05)	2666 (129.06)	4.62 (0.25)	14.90 (0.30)
Ach-INT	0.102 (0.05)	555 (26.40)	2516 (172.04)	5.20 (0.22)	14.55 (0.42)
KpA-INT	0.115 (0.05)	547 (23.97)	2685 (166.20)	5.14 (0.20)	14.94 (0.39)
SM	0.110 (0.01)	567 (18.97)	2417 (122.19)	5.31 (0.16)	14.30 (0.31)
KD	0.111 (0.01)	516 (25.10)	2576 (67.02)	4.87 (0.22)	14.69 (0.16)

n.b. Standard Deviations are in parentheses.

Table 6.6 indicates that [e] from KpA-WE was produced with the longest duration at 0.164 sec compared to the other groups of language consultants, whereas [e] from Ach-INT was produced with the shortest duration at 0.102 sec. The distribution of [e] from KpA-WE, KpA-INT, SM and KD are shown in Figure 6.12. Between SM and KD, [e] is seen to be differentiated by height where KD [e] is seen to be produced higher in the vowel space. Whilst [e] from KpA-WE and KpA-INT is seen to collapse with KD [e] meaning they were produced similarly. Substantial overlap among [e] productions in these three groups of speakers is seen, indicating that they were produced in the same way.

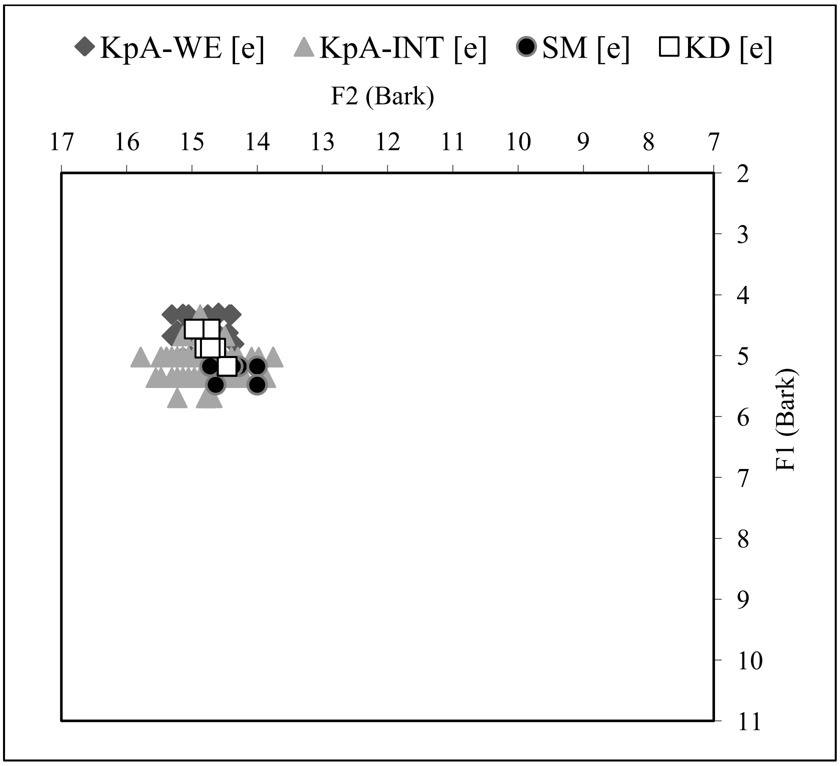


Figure 6.12: Distribution of [e] from KpA-WE, KpA-INT, SM and KD

In 4.2.3.2 and 4.3.3.2, [e] by Ach and KpA language consultants from both contexts was also reported to be produced similarly. The overlapping distribution of [e] produced by Ach and KpA language consultants in both speaking contexts, SM and KD language consultants in the vowel space are shown in Figure 6.13 and Figure 6.14. Again, this indicated similar production of [e] by these language consultants.

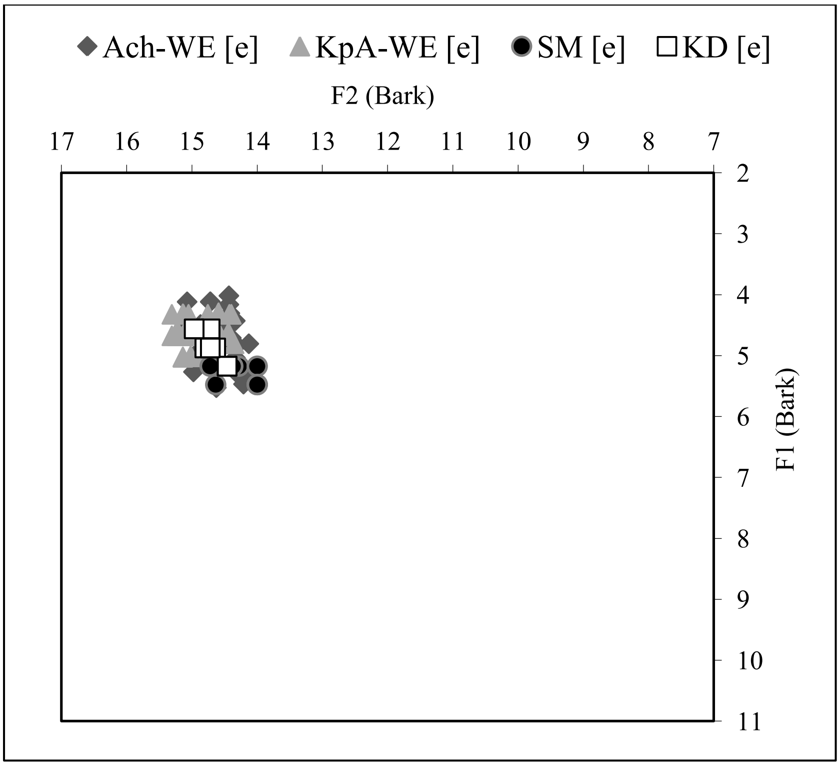


Figure 6.13: Distribution of [e] from Ach-WE, KpA-WE, SM and KD

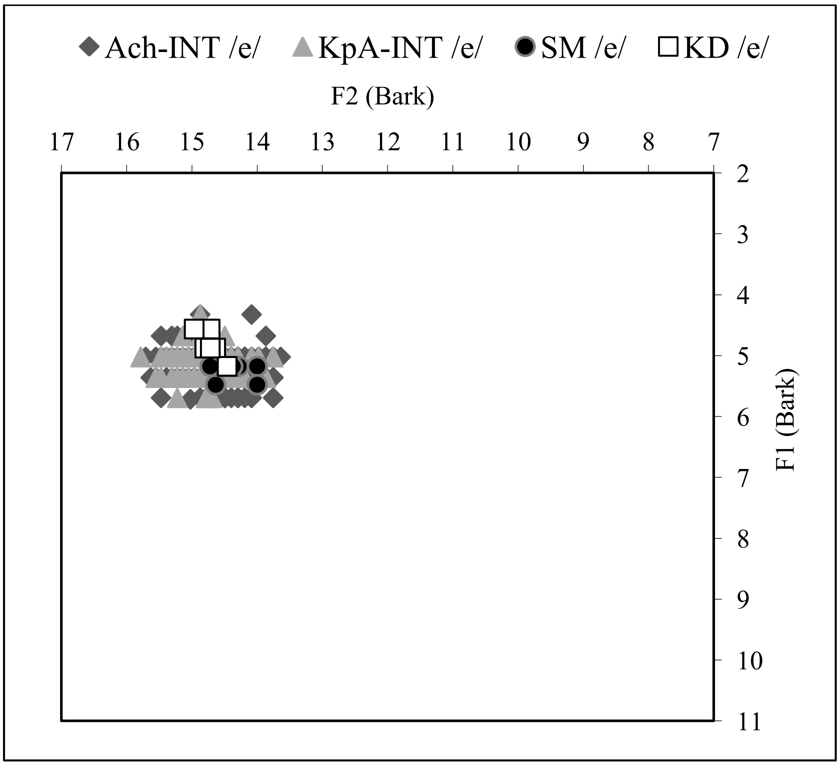


Figure 6.14: Distribution of [e] from Ach-INT, KpA-INT, SM and KD

6.3.1.3 The vowel /ɛ/

KpA, Ach and KD language consultants produced the sound /ɛ/, but SM language consultants did not because it is not in SM vowel inventory. Therefore, the comparison of /ɛ/ is only conducted between KpA, Ach and KD language consultants. To better see the [ɛ] production from these groups of language consultants, Table 6.7 provides their average values of [ɛ] production. The average values of [ɛ] from Ach and KpA language consultants are presented in both WE and INT.

Table 6.7: Measurements of /ɛ/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.158 (0.04)	629 (52.82)	2386 (141.79)	5.82 (0.43)	14.22 (0.36)
KpA-WE	0.111 (0.04)	580 (41.24)	2214 (174.40)	5.42 (0.34)	13.75 (0.45)
Ach-INT	0.104 (0.05)	658 (51.51)	2335 (125.97)	6.06 (0.41)	14.09 (0.33)
KpA-INT	0.118 (0.06)	650 (49.68)	2493 (173.08)	5.99 (0.39)	14.49 (0.43)
KD	0.122 (0.01)	599 (18.00)	2520 (49.01)	5.58 (0.15)	14.56 (0.12)

n.b. Standard Deviations are in parentheses.

From Table 6.7, [ɛ] from Ach-WE was produced with the longest duration at 0.158 sec compared to the other groups of language consultants, whereas [ɛ] from Ach-INT was produced with the shortest duration at 0.104 sec. The distribution of [ɛ] from KpA-WE, KpA-INT and KD is presented in Figure 6.15, which shows overlap between the vowels and this means that they were produced similarly by these two groups of language consultants.

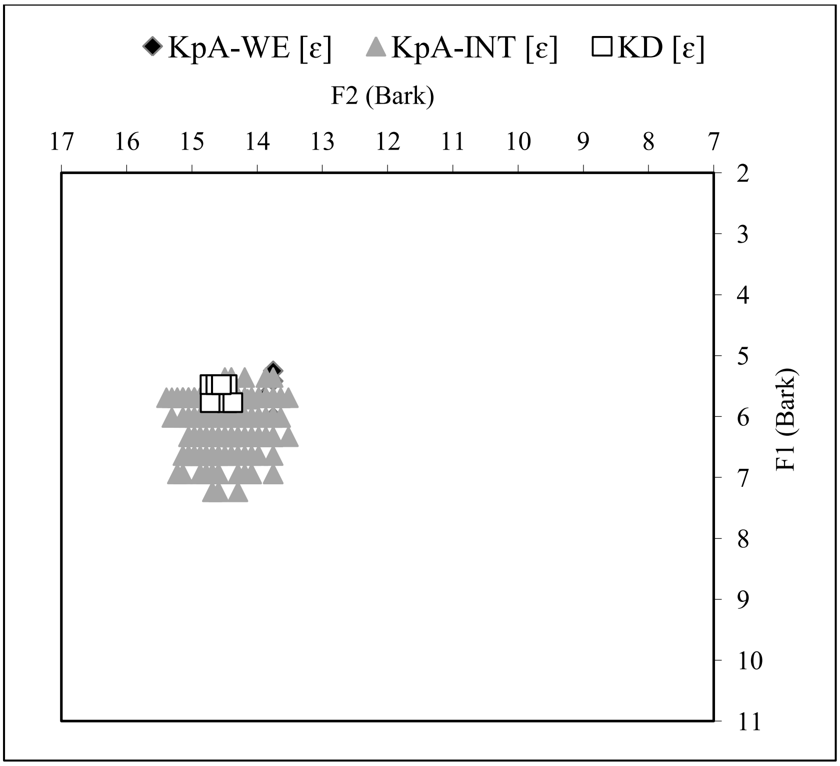


Figure 6.15: Distribution of [ɛ] from KpA-WE, KpA-INT and KD

Ach [ɛ] was also found to be produced with the same quality as KpA [ɛ] from both speaking contexts (see 4.2.3.3 and 4.3.3.3). Based on Figure 6.16 and Figure 6.17, this sound was produced similarly by the three groups of language consultants as the tokens of their productions overlap one another.

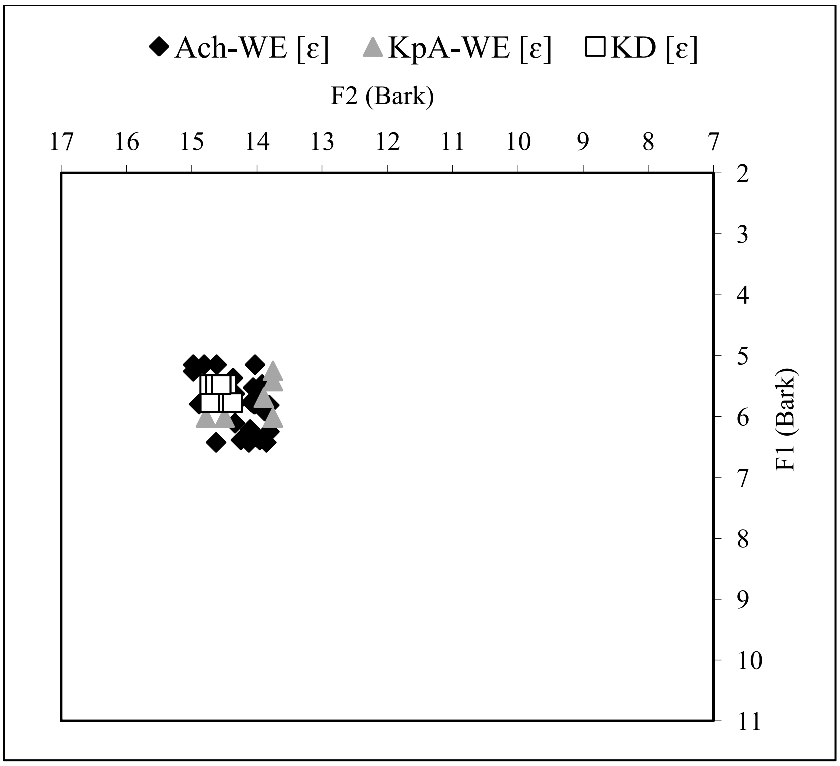


Figure 6.16: Distribution of [ɛ] from Ach-WE, KpA-WE, SM and KD

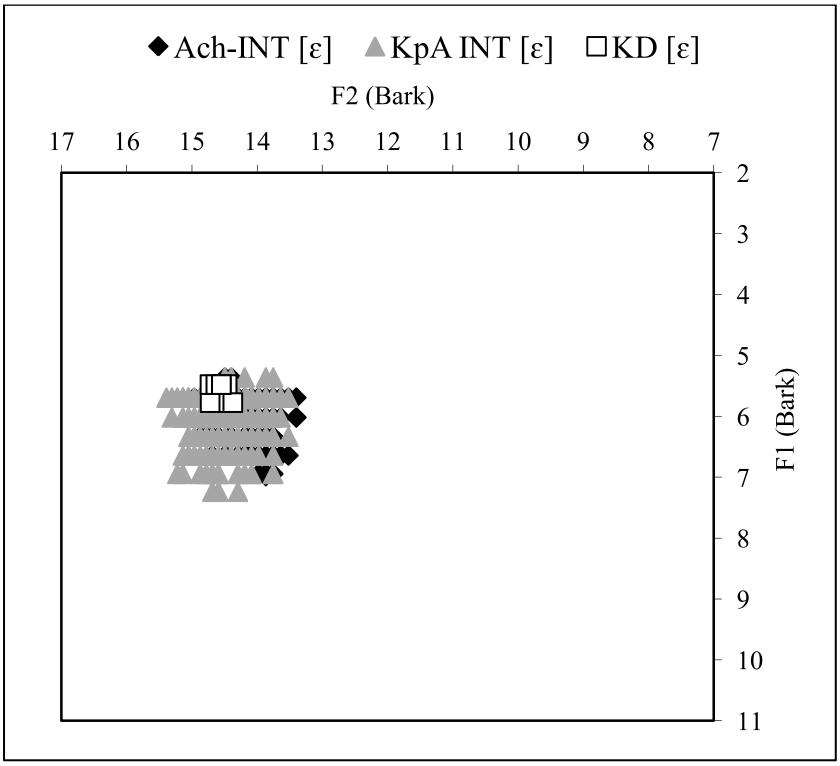


Figure 6.17: Distribution of [ɛ] from Ach-INT, KpA-INT, SM and KD

6.3.1.4 The vowel /ə/

The sound /ə/ was produced by KpA, Ach, SM and KD language consultants. Table 6.8 provides the average values of [ə] production from all four groups of language consultants. The average values of [ə] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.8: Measurements of /ə/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.156 (0.03)	547 (27.20)	1825 (122.35)	5.14 (0.23)	12.51 (0.45)
KpA-WE	0.174 (0.06)	525 (21.34)	1489 (138.00)	4.95 (0.18)	11.15 (0.61)
Ach-INT	0.082 (0.06)	623 (18.52)	1874 (154.18)	5.77 (0.15)	12.68 (0.54)
KpA-INT	0.111 (0.07)	567 (27.60)	1471 (122.40)	5.31 (0.23)	11.07 (0.56)
SM	0.072 (0.02)	583 (28.14)	1889 (91.15)	5.44 (0.23)	12.73 (0.31)
KD	0.073 (0.02)	559 (34.44)	1932 (73.73)	5.24 (0.29)	12.88 (0.25)

n.b. Standard Deviations are in parentheses.

From Table 6.8, [ə] from KpA-WE was produced with the longest average duration at 0.174 sec compared to the other groups of language consultants, whereas [ə] by SM language consultants was produced with the shortest average duration at 0.072 sec. Figure 6.18 illustrates the distribution of [ə] from Ach-WE, KpA-INT, SM and KD in the vowel space. Between SM and KD, the distribution of [ə] is seen to lack contrast, indicating similar productions. KpA-WE and KpA-INT, however, are seen to produce this sound further back than SM and KD. As found in 4.2.3.5 and 4.3.3.5, [ə] by KpA language consultants was realized closer to [ɵ] in both citation and spontaneous contexts. This is also apparent in Figure 6.18 where the distribution of KpA [ə] suggests a sound closer to [ɵ].

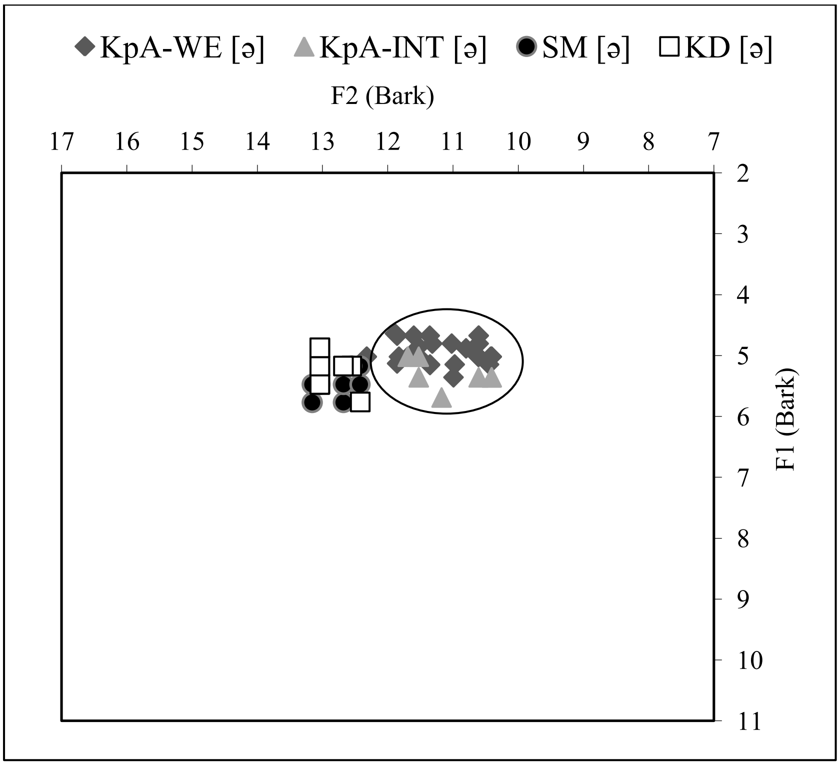


Figure 6.18: Distribution of [ə] from KpA-WE, KpA-INT, SM and KD
n.b. /ə/ is realized closer to [ɵ] KpA language consultants.

In 4.2.3.5 and 4.3.3.5, [ə] in Ach-WE and Ach-INT was also reported to be produced differently from KpA-WE and KpA-INT whereby [ə] in both contexts were realized closer to [ɵ] by KpA language consultants and lip rounding was observed by the researcher during the recording sessions. Looking at Figure 6.19 and Figure 6.20, it is seen that [ə] in Ach-WE and Ach-INT was closer to SM and KD in its production as their tokens are overlapping.

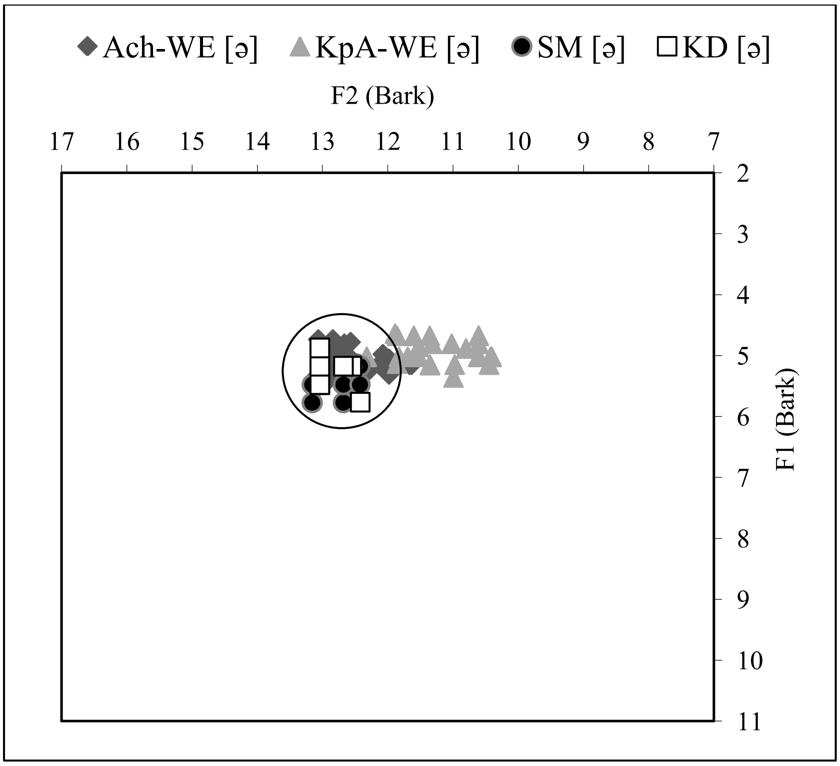


Figure 6.19: Distribution of [ə] in Ach-WE, KpA-WE, SM and KD
n.b. Tokens of /ə/ by Ach, SM and KD language consultants overlap.

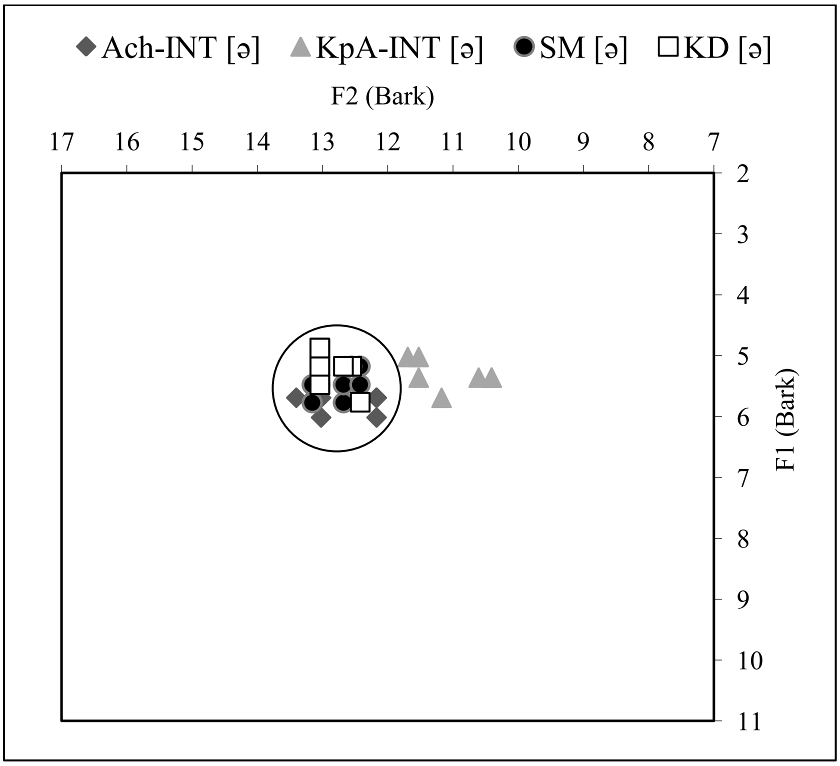


Figure 6.20: Distribution of [ə] from Ach-INT, KpA-INT, SM and KD
n.b. Tokens of [ə] from Ach, SM and KD language consultants overlaps.

6.3.1.5 The vowel /a/

The sound /a/ was produced by KpA, Ach, SM and KD language consultants. To better compare the [a] production from all groups of language consultants, Table 6.9 provides their average values of [a] production. The average values of [a] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.9: Measurements of /a/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.165 (0.06)	877 (51.40)	1831 (65.49)	7.69 (0.36)	12.53 (0.23)
KpA-WE	0.176 (0.03)	928 (83.63)	1995 (57.67)	8.04 (0.55)	13.09 (0.19)
Ach-INT	0.104 (0.05)	880 (87.81)	1854 (123.20)	7.71 (0.59)	12.61 (0.45)
KpA-INT	0.097 (0.04)	860 (92.66)	1875 (189.20)	7.57 (0.64)	12.69 (0.67)
SM	0.121 (0.02)	948 (32.96)	1706 (39.88)	8.17 (0.11)	12.06 (0.16)
KD	0.143 (0.03)	861 (53.58)	1856 (92.62)	7.58 (0.38)	12.62 (0.33)

n.b. Standard Deviations are in parentheses.

Based on Table 6.9, [a] from KpA-WE was produced with the longest duration at 0.176 sec compared to the other groups of language consultants, whereas KpA-INT produced it with the shortest duration at 0.097 sec. Figure 6.21 shows the distribution of [a] in KpA-WE, KpA-INT, SM and KD in the vowel space. Between SM and KD, [a] is differentiated by height with most tokens from KD distributed higher than those from SM. Thus, the distribution of [a] from the three groups of language consultants shows a considerable overlap, suggesting that this sound was produced similarly.

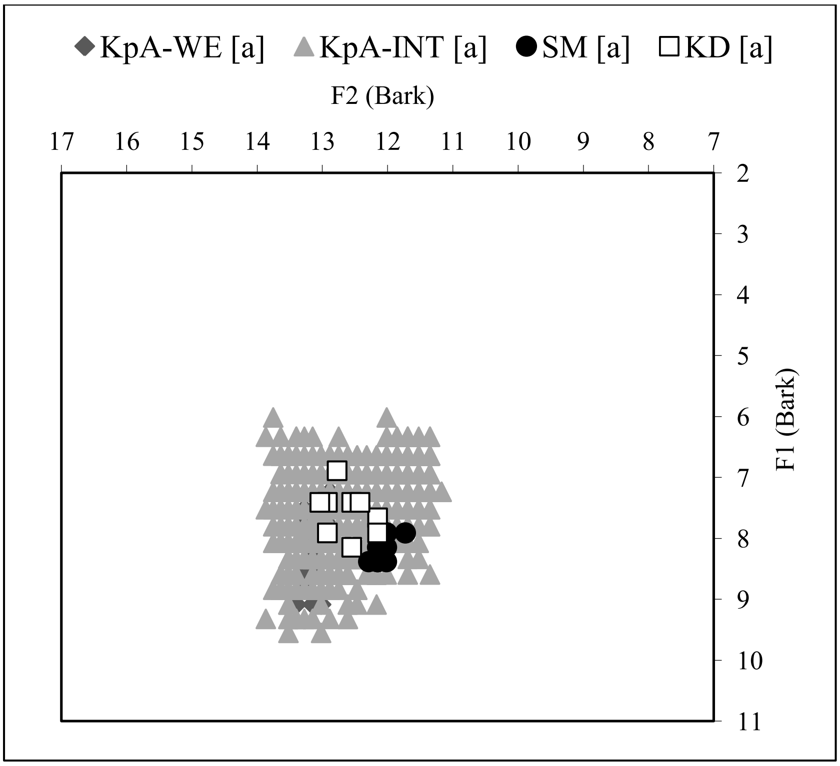


Figure 6.21: Distribution of [a] from KpA-WE, KpA-INT, SM and KD

The findings in 4.2.3.7 reported that KpA-WE [a] was produced more fronted than Ach-WE [a] but similarly in the INT context. Figure 6.22 further shows that [a] in Ach-WE overlap with SM and KD, suggesting they were produced similarly. Again, its distribution in KpA-WE are seen to be more fronted than the others. Hence, Figure 6.23 further shows the production of [a] in Ach-INT and KpA-INT, SM and KD. Here, the tokens overlap significantly and this means that all four groups of language consultants produced it in the same way.

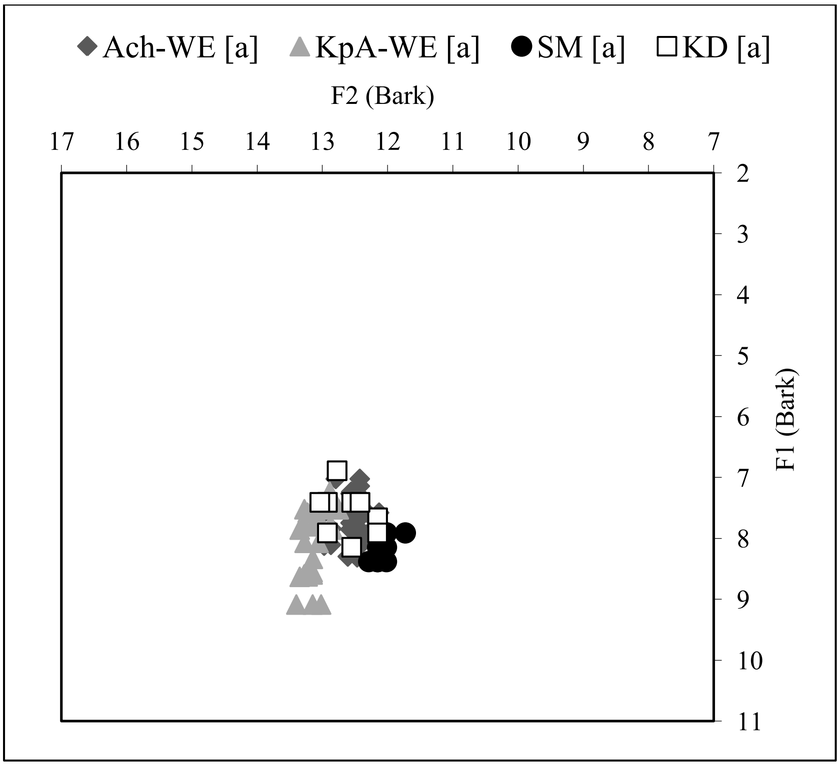


Figure 6.22: Distribution of [a] from Ach-WE, KpA-WE, SM and KD.

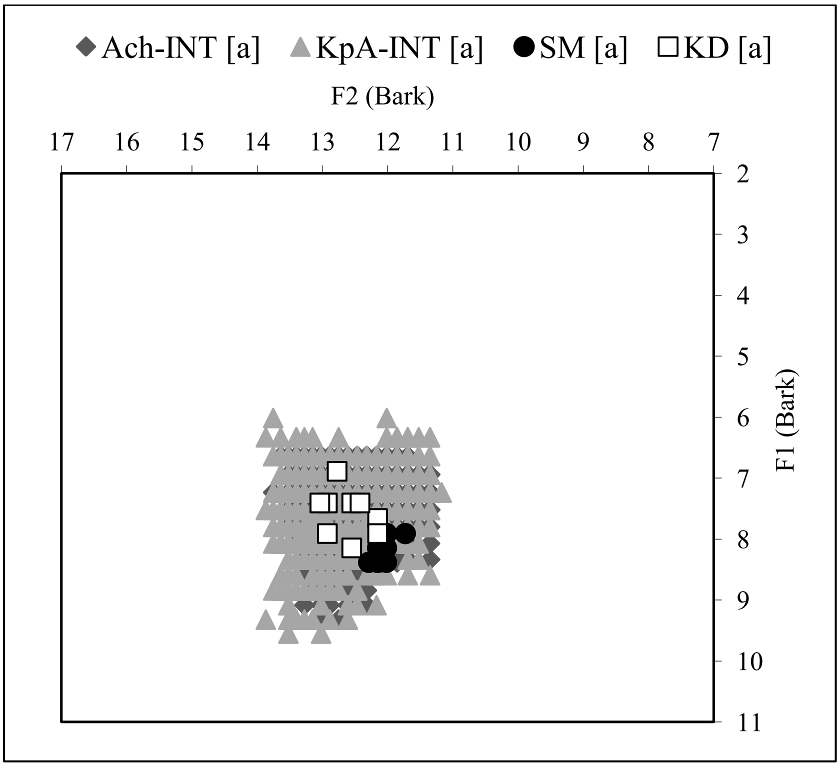


Figure 6.23: Distribution of [a] from Ach-INT, KpA-INT, SM and KD.

6.3.1.6 The vowel /u/

The sound /u/ was produced by KpA, Ach, SM and KD language consultants. To better compare the [u] production from all four groups of language consultants, Table 6.10 provides their average values of [u] production. The average values of [u] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.10: Measurements of /u/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.188 (0.16)	463 (37.95)	1367 (114.82)	4.41 (0.34)	10.58 (0.56)
KpA-WE	0.161 (0.03)	455 (32.79)	1499 (162.44)	4.35 (0.29)	11.19 (0.71)
Ach-INT	0.097 (0.05)	486 (40.30)	1181 (134.09)	4.61 (0.35)	9.60 (0.74)
KpA-INT	0.099 (0.05)	503 (22.89)	1290 (109.16)	4.76 (0.20)	10.19 (0.57)
SM	0.103 (0.01)	468 (25.16)	1028 (50.41)	4.46 (0.22)	8.69 (0.31)
KD	0.102 (0.02)	421 (17.59)	1052 (50.12)	4.03 (0.16)	8.83 (0.31)

n.b. Standard Deviations are in parentheses.

Based on Table 6.10, [u] from Ach-WE was produced with the longest duration at 0.188 sec compared to the other groups of language consultants, whereas Ach-INT produced it with the shortest duration at 0.097 sec. Figure 6.24 shows the distribution of [u] in KpA-WE, KpA-INT, SM and KD in the vowel space. Between SM and KD, their tokens overlap; this means similar productions. The sound [u] in KpA-WE and KpA-INT, however, are seen to have tokens that are more fronted than SM and KD.

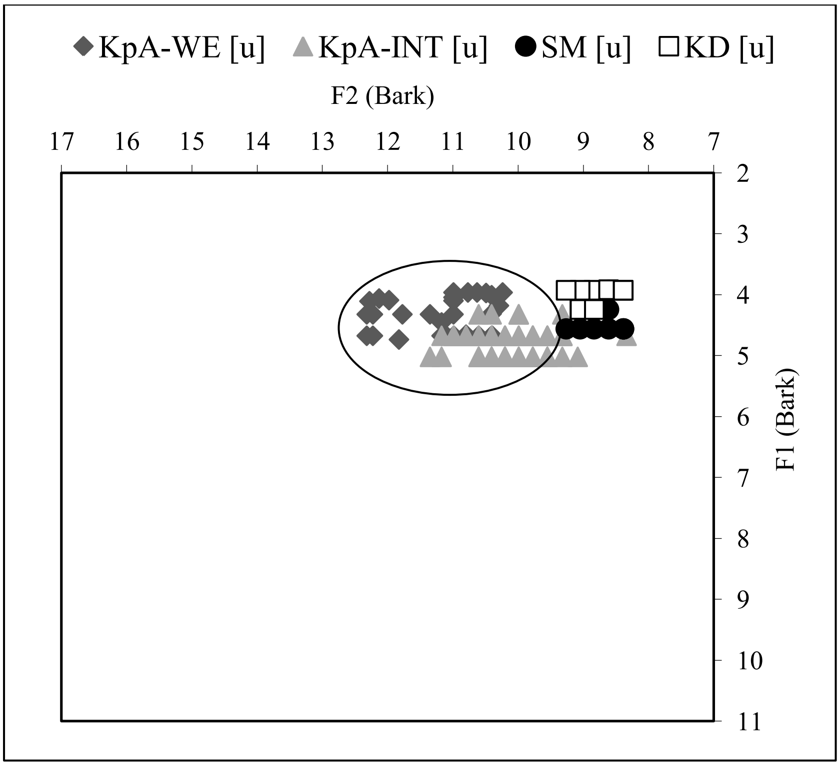


Figure 6.24: Distribution of [u] from KpA-WE, KpA-INT, SM and KD

The findings in 4.2.3.8 revealed that [u] was produced similarly in Ach-WE and KpA-WE. Figure 6.25 further shows that [u] in Ach-WE and KpA-WE were produced more fronted than SM and KD language consultants. Moreover, the findings in 4.3.3.8 reported that in INT, Ach and KpA [u] were also produced with the same quality. Similarly, Figure 6.26 presents the distribution of [u] in Ach-INT, KpA-INT, SM and KD overlapping each other, suggesting that these four groups of language consultants produced this vowel similarly.

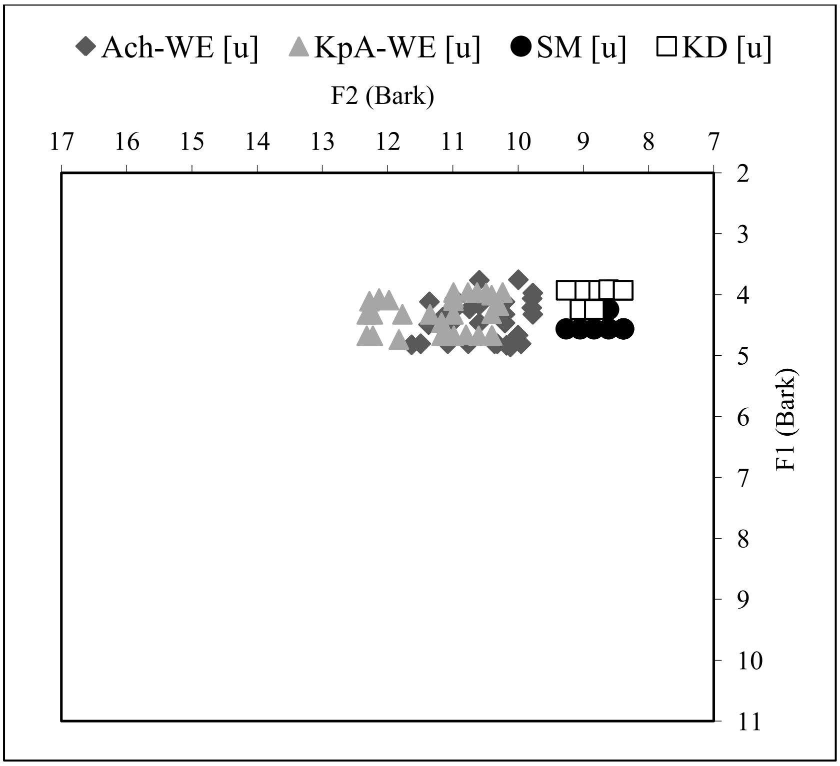


Figure 6.25: Distribution of [u] from Ach-WE, KpA-WE, SM and KD

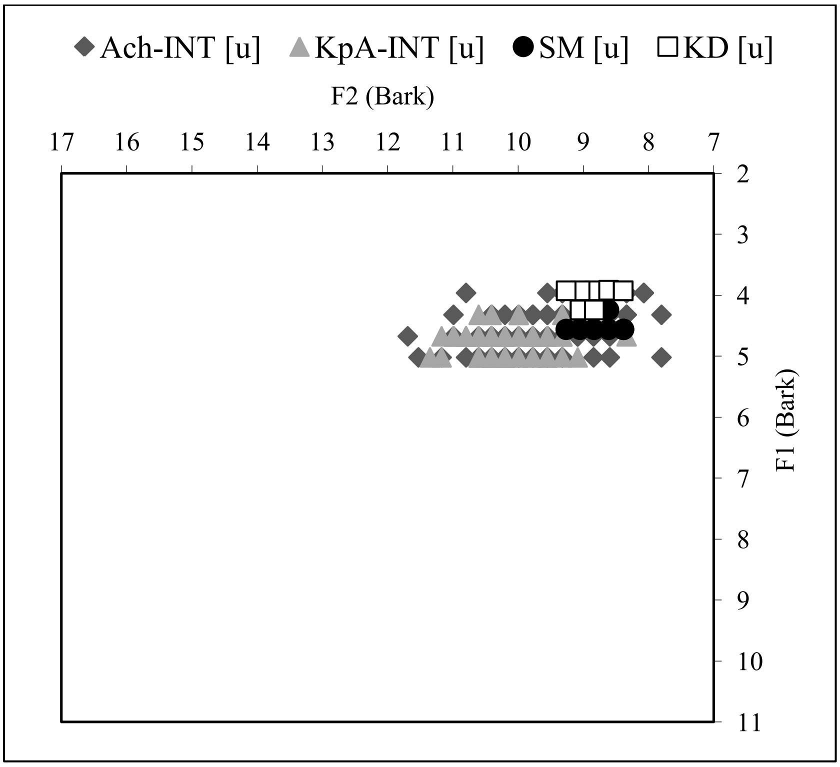


Figure 6.26: Distribution of [u] from Ach-INT, KpA-INT, SM and KD

6.3.1.7 The vowel /o/

All four groups of KpA, Ach, SM and KD language consultants produced /o/ in their speech. To better see the [o] production from these language consultants, Table 6.11 provides their average values of [o] production. The average values of [o] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.11: Measurements of /o/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.158 (0.05)	531 (38.90)	1013 (85.61)	5.01 (0.33)	8.60 (0.55)
KpA-WE	0.173 (0.04)	499 (27.77)	1124 (80.62)	4.73 (0.24)	9.27 (0.47)
Ach-INT	0.106 (0.05)	550 (26.76)	1186 (109.32)	5.17 (0.23)	9.63 (0.61)
KpA-INT	0.115 (0.06)	548 (26.56)	1209 (117.65)	5.15 (0.23)	9.75 (0.66)
SM	0.130 (0.02)	579 (34.51)	1182 (24.99)	5.41 (0.29)	9.60 (0.29)
KD	0.151 (0.03)	504 (18.00)	1159 (35.50)	4.77 (0.16)	9.47 (0.20)

n.b. Standard Deviations are in parentheses.

From Table 6.11, [o] from KpA-WE was produced with the longest duration at 0.173 sec compared to the other groups of language consultants, whereas Ach-INT produced it with the shortest duration at 0.106 sec. The distribution of [o] in KpA-WE, KpA-INT with SM and KD are shown in Figure 6.27. It is shown that between the three language consultants, the distribution of [o] overlap, suggesting that they were produced similarly.

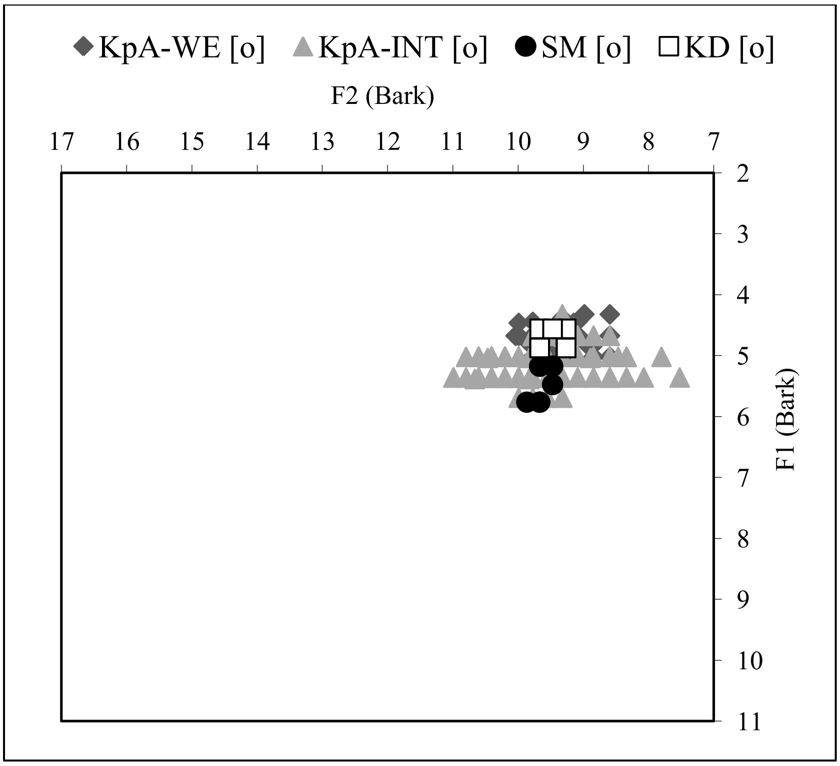


Figure 6.27: Distribution of [o] from KpA-WE, KpA-INT, SM and KD

Looking back at the findings in 4.2.3.9 from WE, KpA [o] was produced more fronted than Ach [o]. Based on this citation context, Figure 6.28 also shows that [o] in KpA-WE, SM and KD are more fronted than Ach [o]. However, the findings in 4.3.3.9 showed that for INT, Ach and KpA [o] were produced in the same way. Figure 6.29 further shows that the distribution of [o] in Ach-INT, KpA-INT, SM and KD overlap in the vowel space, suggesting similar productions.

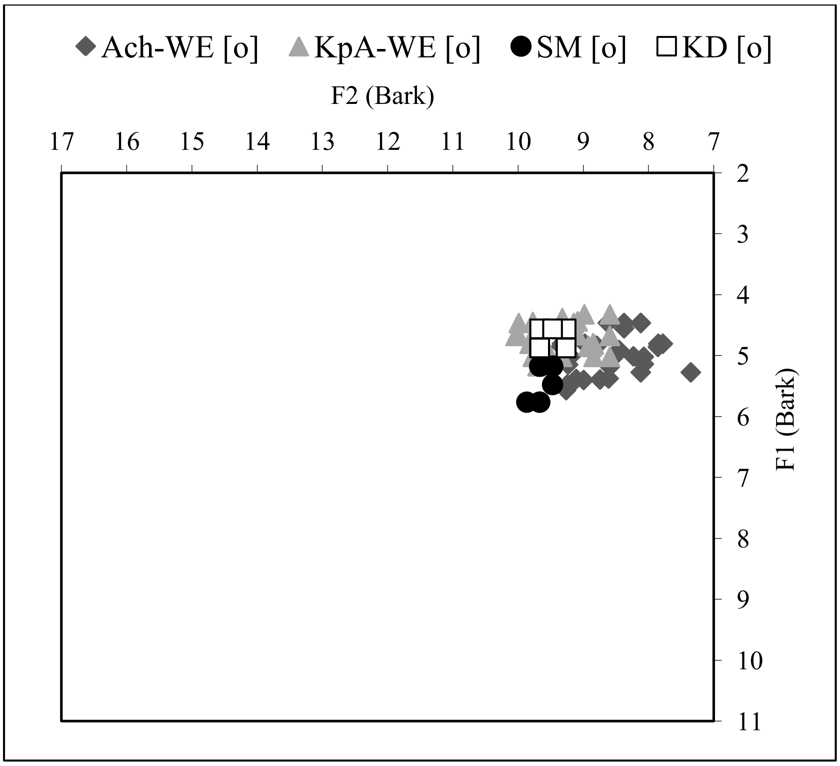


Figure 6.28: Distribution of [o] from Ach-WE, KpA-WE, SM and KD

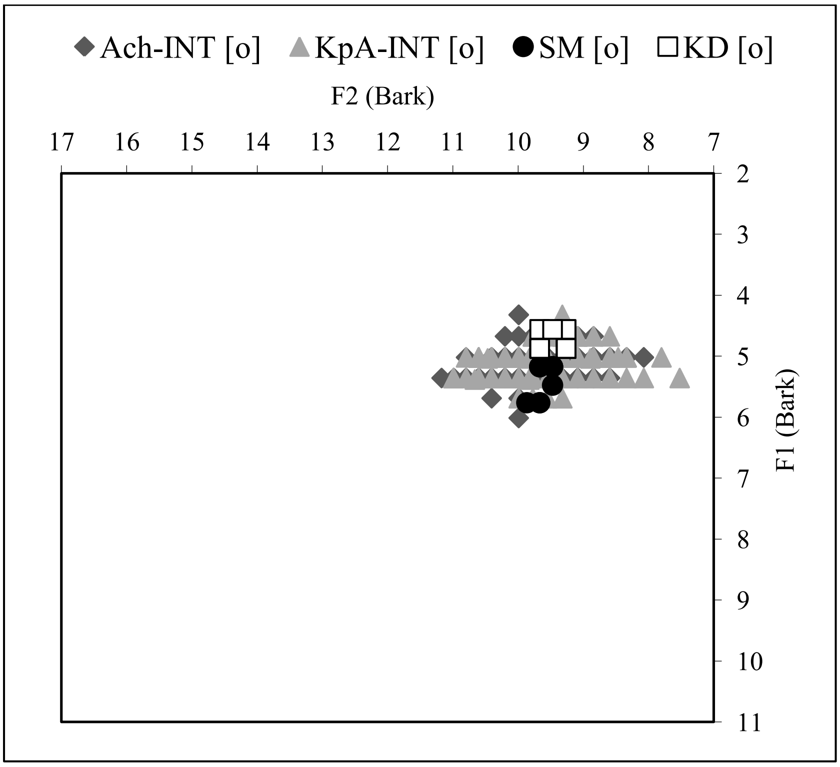


Figure 6.29: Distribution of [o] from Ach-INT, KpA-INT, SM and KD

6.3.1.8 The vowel /ɔ/

The sound /ɔ/ does not occur in SM. Therefore, the comparison of this sound is only conducted between KpA, Ach and KD language consultants. Table 6.12 provides the average values of [ɔ] production from these three groups of language consultants. The average values of [ɔ] from Ach and KpA language consultants are presented from both WE and INT.

Table 6.12: Measurements of /ɔ/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 (Hz)	Ave F2 (Hz)	Ave F1 (Bark)	Ave F2 (Bark
Ach-WE	0.150 (0.04)	669 (43.49)	1412 (113.26)	6.14 (0.35)	10.79 (0.53)
KpA-WE	0.172 (0.04)	648 (37.75)	1380 (84.80)	5.98 (0.30)	10.64 (0.42)
Ach-INT	0.109 (0.06)	659 (48.57)	1289 (139.49)	6.07 (0.38)	10.18 (0.72)
KpA-INT	0.105 (0.05)	648 (47.73)	1278 (120.96)	5.98 (0.38)	10.12 (0.63)
KD	0.151 (0.02)	595 (15.87)	1186 (66.33)	5.54 (0.13)	9.63 (0.37)

n.b. Standard Deviations are in parentheses.

Based on Table 6.12, [ɔ] from KpA-WE was produced with the longest duration at 0.172 sec compared to the other groups of language consultants; whereas KpA-INT produced it with the shortest duration at 0.105 sec. Figure 6.30 presents the distribution of [ɔ] in KpA-WE, KpA-INT and KD. It shows the overlapping tokens of [ɔ] from both groups of language consultants that suggests similar productions.

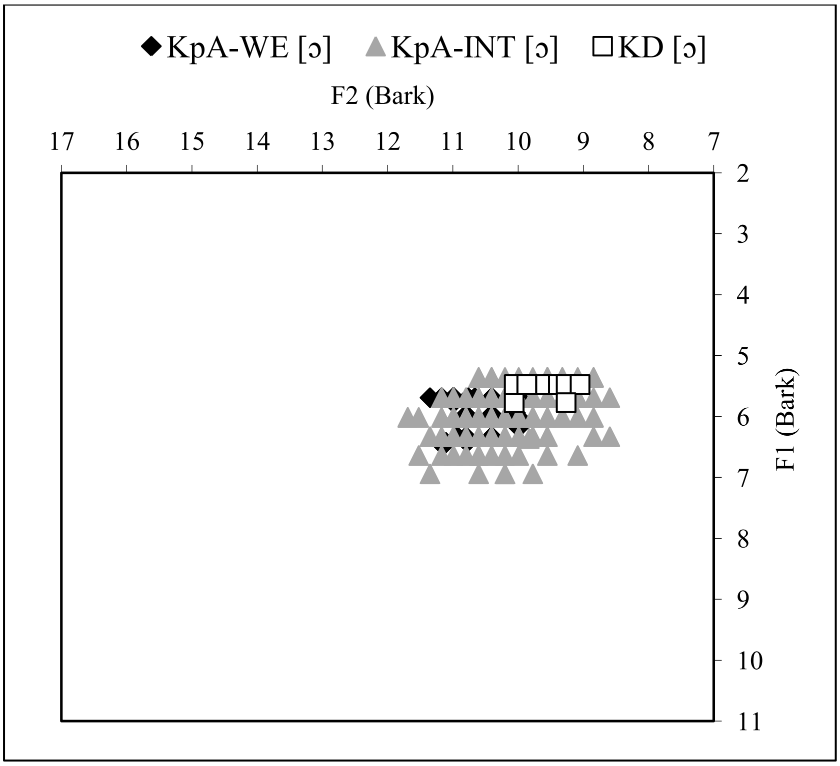


Figure 6.30: Distribution of [ɔ] from KpA-WE and KD

Ach [ɔ] was also found to be produced with the same quality as KpA [ɔ] in both speaking contexts (see 4.2.3.10 and 4.3.3.10). Similar to Figure 6.30, Figure 6.31 also shows that [ɔ] in Ach-WE is similar to KpA-WE, but more fronted than KD. Hence, Figure 6.32 shows [ɔ] in Ach-INT, KpA-INT and KD clearly display overlapping distribution, which means that they were produced with the same quality.

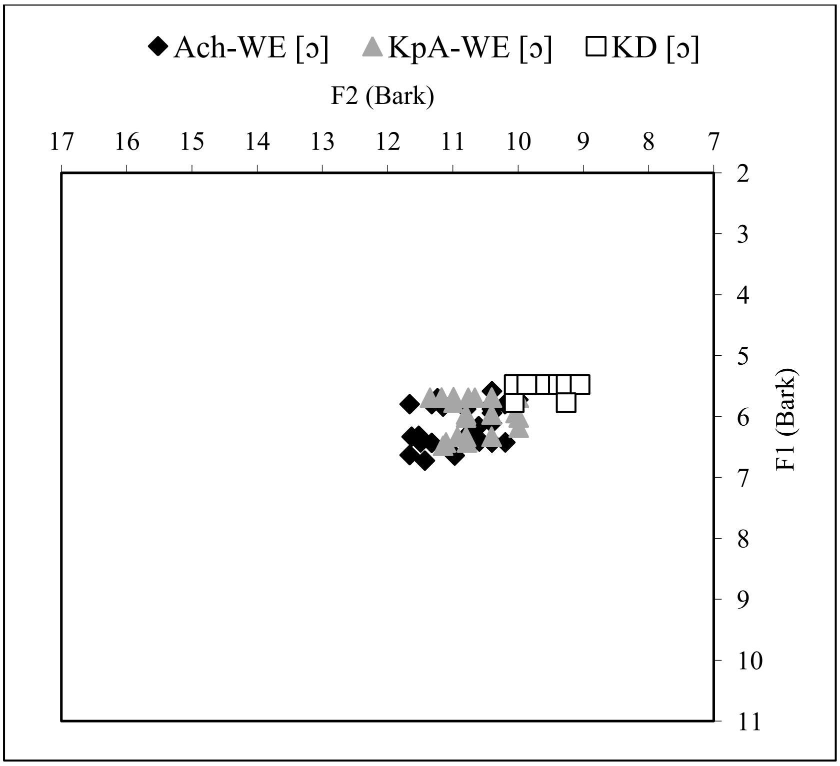


Figure 6.31: Distribution of [ɔ] from Ach-WE, KpA-WE, SM and KD

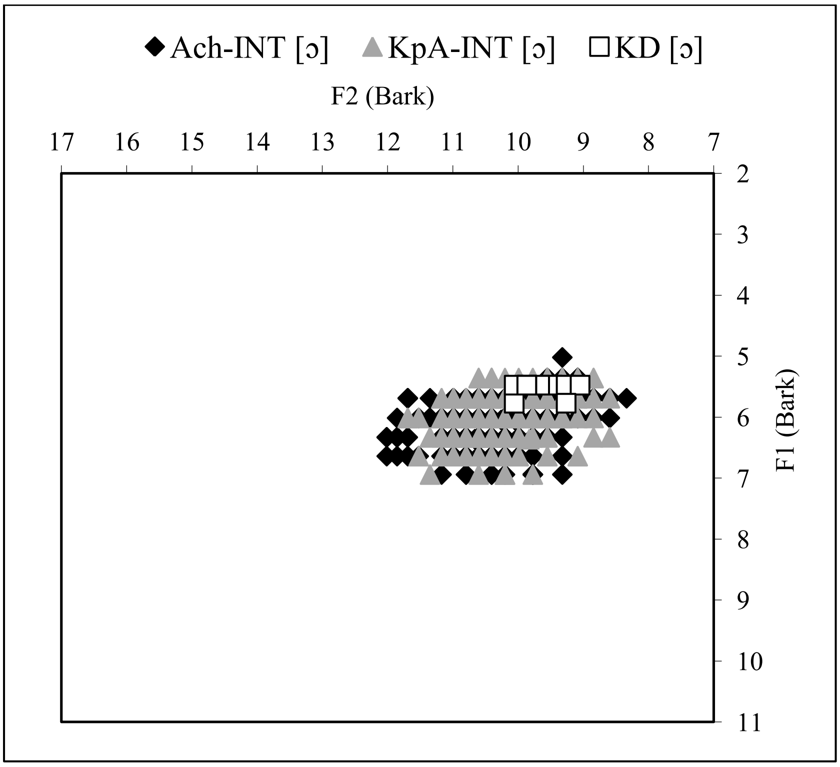


Figure 6.32: Distribution of [ɔ] from Ach-INT, KpA-INT, SM and KD

6.3.2 Comparison of Diphthongs

The comparison for diphthongs production from KpA, SM and KD language consultants are presented in this section. Further comparisons with Ach language consultants were also conducted to investigate the influences they had among each other for the vowels produced by these four groups of language consultants. The diphthongs /ai/ and /oi/ were studied from all groups of language consultants, whilst the production of /ui/ was only conducted between Ach, KpA and KD language consultants as SM does not have this diphthong in its inventory. The sound /au/ was excluded as only SM and KD have this diphthong. Other Acehnese diphthongs not mentioned were also excluded as they are not found in SM and KD vowel inventories, therefore, comparisons could not be made.

6.3.2.1 The vowel /ai/

The vowel /ai/ was produced by KpA, Ach, SM and KD language consultants. To better see the duration and the F1 and F2 average values of [ai] production from all language consultants, Table 6.13 provides their average values of [ai] production. For Ach and KpA [ai], the average values are presented from both WE and INT.

Table 6.13: Measurements of /ai/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 ROC	Ave F2 ROC
Ach-WE	0.232 (0.07)	-1643 (927)	2985 (924)
KpA-WE	0.233 (0.06)	-1607 (471)	2649 (871)
Ach-INT	0.106 (0.04)	-2290 (1609)	3900 (3031)
KpA-INT	0.125 (0.07)	-941 (1340)	3144 (3637)
SM	0.128 (0.02)	-2798 (695.25)	6337 (1671.15)
KD	0.158 (0.04)	-2642 (1065.91)	5485 (2316.05)

n.b. Standard Deviations are in parentheses.

Based on their F2 ROC average value in Table 6.13, SM language consultants produced this diphthong with the largest movement, followed by KD language consultants and lastly KpA language consultants. This can be seen in Figure 6.33 that shows trajectories of [ai] in KpA-WE, KpA-INT, SM and KD. The onset of [ai] from SM is also seen to be positioned further back compared to KpA-WE, KpA-INT and KD. KpA-INT [ai] is seen to have the smallest movement and starts with a higher onset compared to SM and KD; this is perhaps due to its extraction that was from continuous speech whilst SM and KD were derived from word citations.

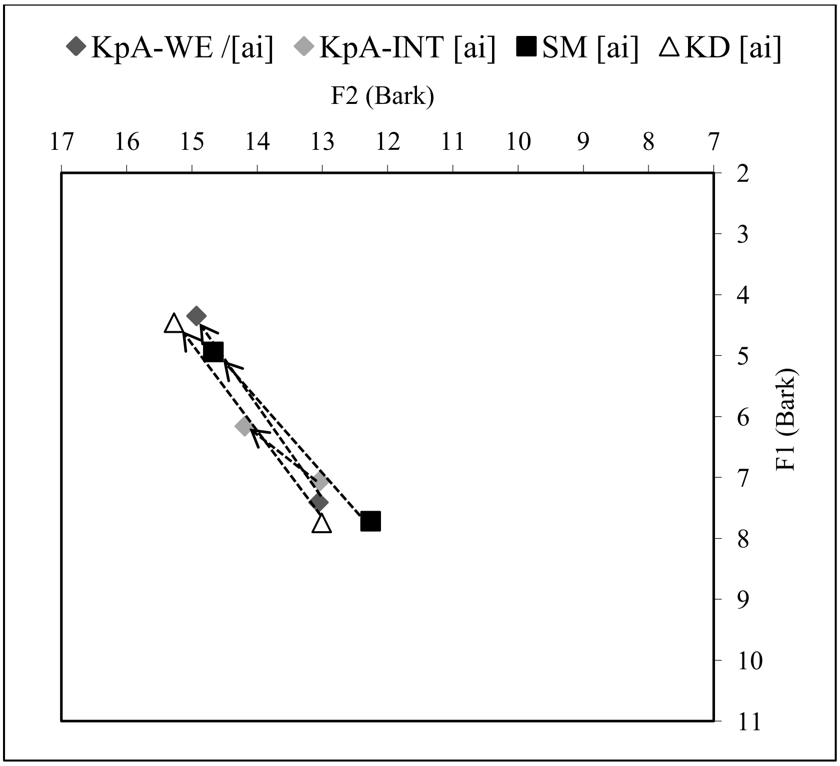


Figure 6.33: Trajectories of [ai] from KpA-WE, KpA-INT, SM and KD

Ach /ai/ from WE was also found to be produced similarly with KpA [ai] (see 5.2.3.12). Figure 6.34 displays the trajectories of Ach and KpA [ai] from WE, SM and KD. Again, SM [ai] is seen to have an onset further back than the others. KpA-WE [ai] is seen to have an onset closer to KD. Furthermore, Figure 6.35 presents trajectories of Ach and KpA [ai] from INT, SM and KD. Due to the different context of vowel extractions, Ach and KpA [ai] from INT are seen to have smaller movements compared to SM and KD. Once more, the onset of SM [ai] is seen to be further back compared to the others.

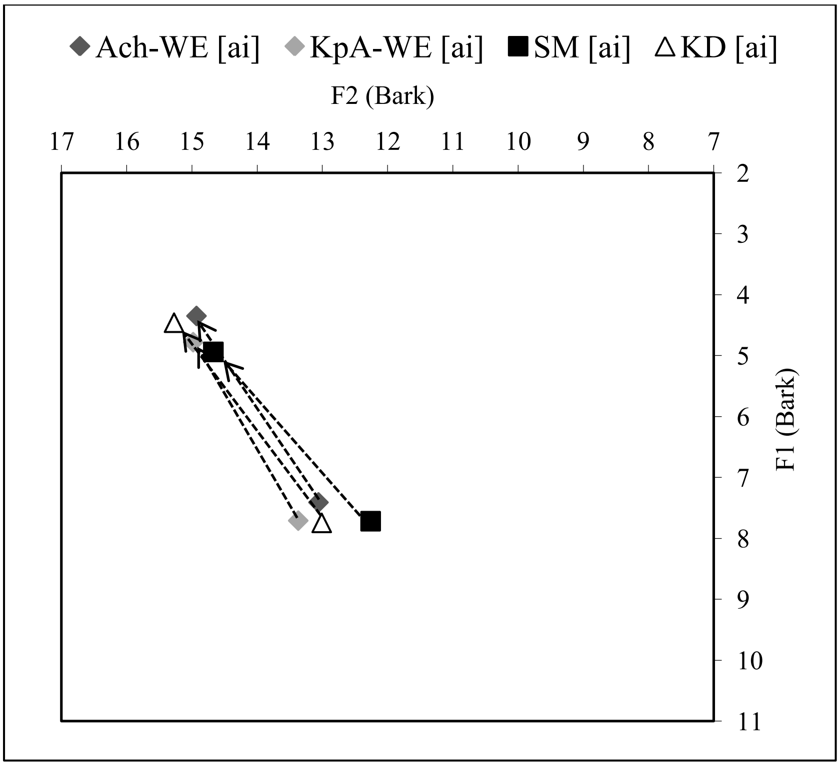


Figure 6.34: Trajectories of [ai] from Ach-WE, KpA-WE, SM and KD

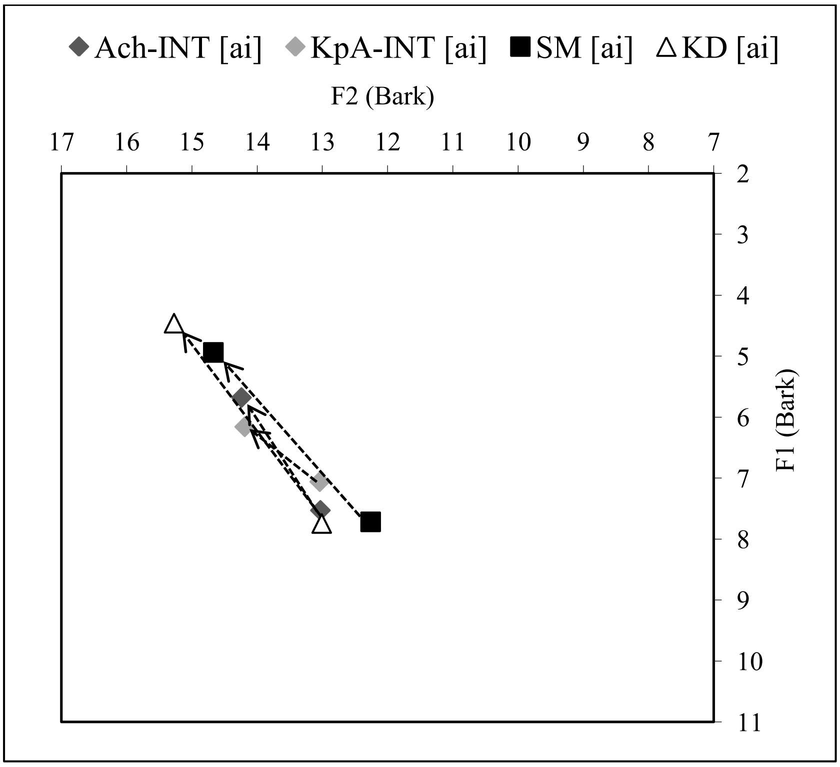


Figure 6.35: Trajectories of [ai] from Ach-INT, KpA-INT, SM and KD

6.3.2.2 The vowel /ui/

The vowel /ui/ was produced by KpA, Ach and KD language consultants, whereas SM does not have this vowel in its inventory. To better compare the duration and the F1 and F2 average values of [ui] productions from all language consultants, Table 6.14 provides their average values of [ui] production. For Ach and KpA [ui], the average values are presented from both WE and INT.

Table 6.14: Measurements of /ui/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 ROC	Ave F2 ROC
Ach-WE	0.242 (0.08)	6 (407)	6891 (2406)
KpA-WE	0.229 (0.04)	-82 (159)	7213 (1580)
Ach-INT	0.073 (0.00)	0 (0)	7685 (0)
KpA-INT	0.093 (0.00)	-430 (0)	17215 (0)
KD	0.230 (0.07)	-54 (258.89)	7533 (2306.94)

n.b. Standard Deviations are in parentheses.

Looking at the F1 and F2 ROC average values between KpA-WE and KD in Table 6.14, both seems to have similar trajectories as shown in Figure 6.36. However, the onset and offset of [ui] in KpA-WE was produced higher than KD as seen in the vowel space. Further, [ui] in KpA-INT was also produced higher than KD, with its offset more fronted and lower than that in KpA-WE. Based on its larger F2 ROC average value, KpA-INT [ui] was produced with more movement compared to KD.

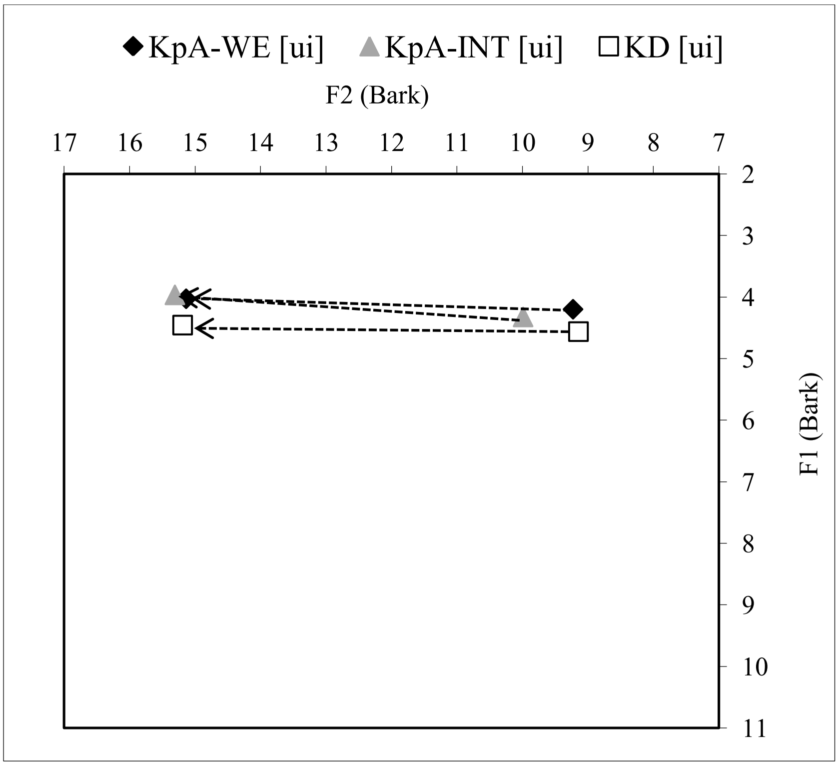


Figure 6.36: Trajectories of [ui] from KpA-WE and KD

Ach [ui] from WE was also found to be produced similarly with KpA [ui] (see 5.2.3.7). Figure 6.37 shows the trajectories of Ach and KpA [ui] from WE and KD. Again, it displays that trajectory of [ui] from KD was produced with a lower onset and offset compared to Ach and KpA [ui] from WE. Based on its F2 ROC average values, KpA-WE and KD language consultants produced [ui] with more movement compared to Ach-WE. From INT, KpA [ui] was found to be produced with a greater diphthongal movement based on its larger F2 ROC average value compared to Ach [ui] (see 5.3.3.7). Figure 6.38 presents trajectories of [ui] from Ach-INT, KpA-INT and KD. KpA-INT and KD seems to have longer trajectories of [ui] compared to Ach-INT. However, we must bear in mind that the measurements of [ui] by Ach-INT and KpA-INT were both extracted from one token each.

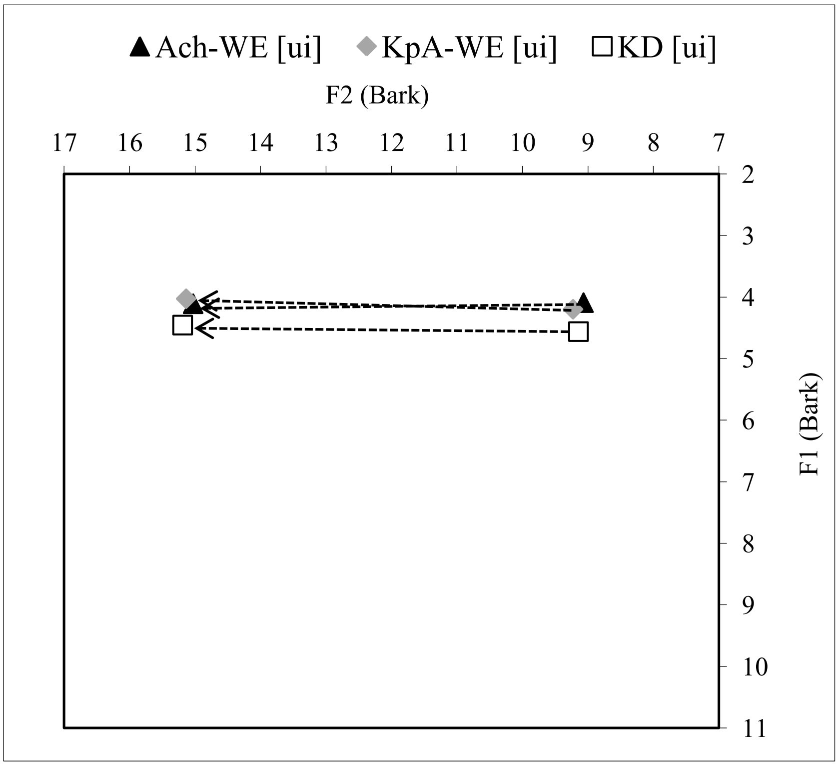


Figure 6.37: Trajectories of [ui] from Ach-WE, KpA-WE and KD

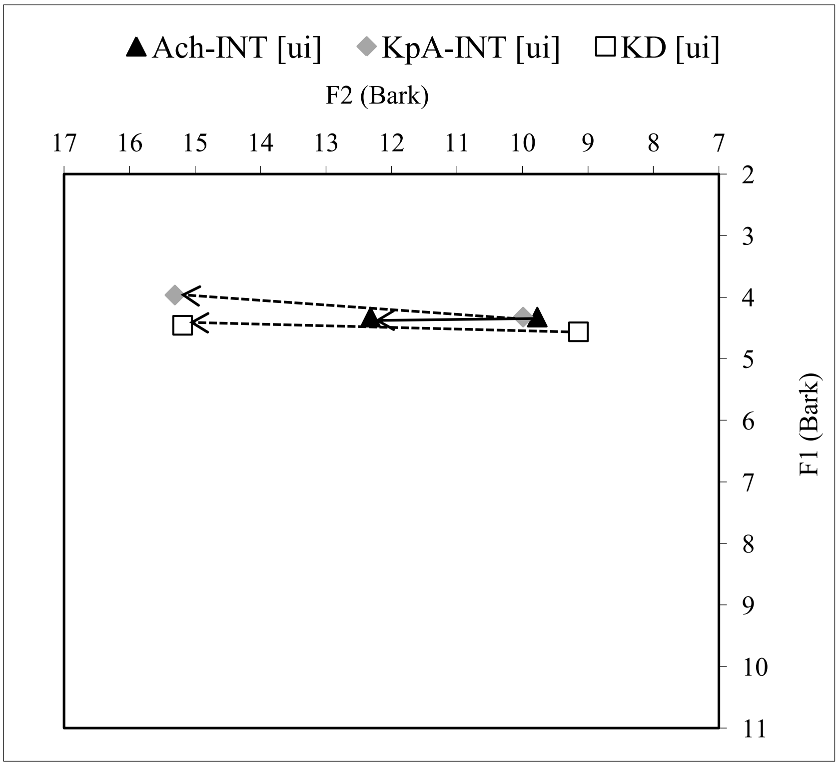


Figure 6.38: Trajectories of [ui] from Ach-INT, KpA-INT and KD

6.3.2.3 The vowel /oi/

The vowel /oi/ was produced by KpA, Ach, SM and KD language consultants. Table 6.15 provides the average duration and the F1 and F2 ROC average values of [oi] production from all four groups of language consultants to better compare its production between them. For Ach and KpA [oi], the average values are presented from both WE and INT.

Table 6.15: Measurements of /oi/ from all language consultants.

Language Consultant	Duration (sec)	Ave F1 ROC	Ave F2 ROC
Ach-WE	0.259 (0.07)	-10 (363)	5810 (2107)
KpA-WE	0.241 (0.05)	-210 (158)	6685 (1360)
Ach-INT	0.093 (0.04)	-431 (1687)	11123 (7442)
KpA-INT	0.119 (0.04)	-10 (729)	9453 (3752)
SM	0.104 (0.02)	-534 (452.54)	12609 (21.23.63)
KD	0.172 (0.05)	-391 (446.06)	9152 (3703.70)

n.b. Standard Deviations are in parentheses.

Based on Table 6.15, SM has the largest F2 ROC value and this indicates that [oi] was produced with the largest movement, followed by KD and finally KpA-WE. This can be seen in Figure 6.39 that illustrates the trajectories of [oi] in KpA-WE, KpA-INT, SM and KD. The onset and offset of [oi] from KpA-WE is seen to be positioned higher in the vowel space compared to SM and KD. Furthermore, [oi] from KpA-INT has an onset further front and offset lower than SM and KD. Once more, this is perhaps because of the different manners of vowel extraction, where KpA-INT was from continuous speech whilst SM and KD were from word citations.

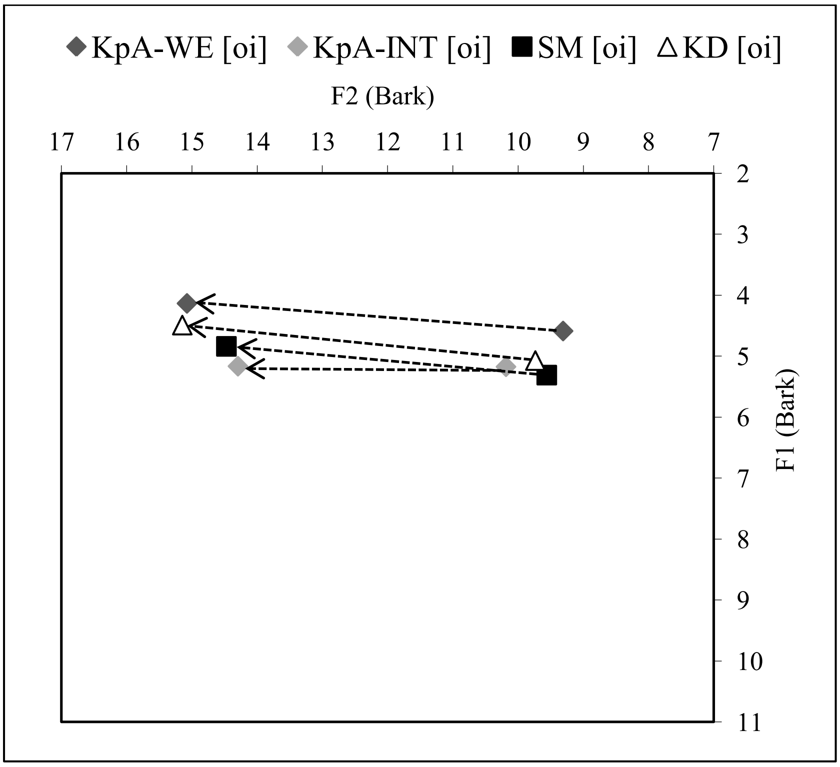


Figure 6.39: Trajectories of [oi] from KpA-WE, KpA-INT, SM and KD

The sound [oi] in Ach from WE and INT was also found to be produced similarly with KpA [oi] (see 5.2.3.9 and 5.3.3.9). Figure 6.40 displays the trajectories of [oi] in Ach-WE, KpA-WE, SM and KD. Again, KpA-INT [oi] was produced with onset and offset higher than the others in the vowel space. Furthermore, Figure 6.41 presents the trajectories of [oi] in Ach-INT, KpA-INT, SM and KD. Looking at the close productions among the onsets and offsets by the four groups of language consultants and the similar trajectories, it can be said that they were produced similarly.

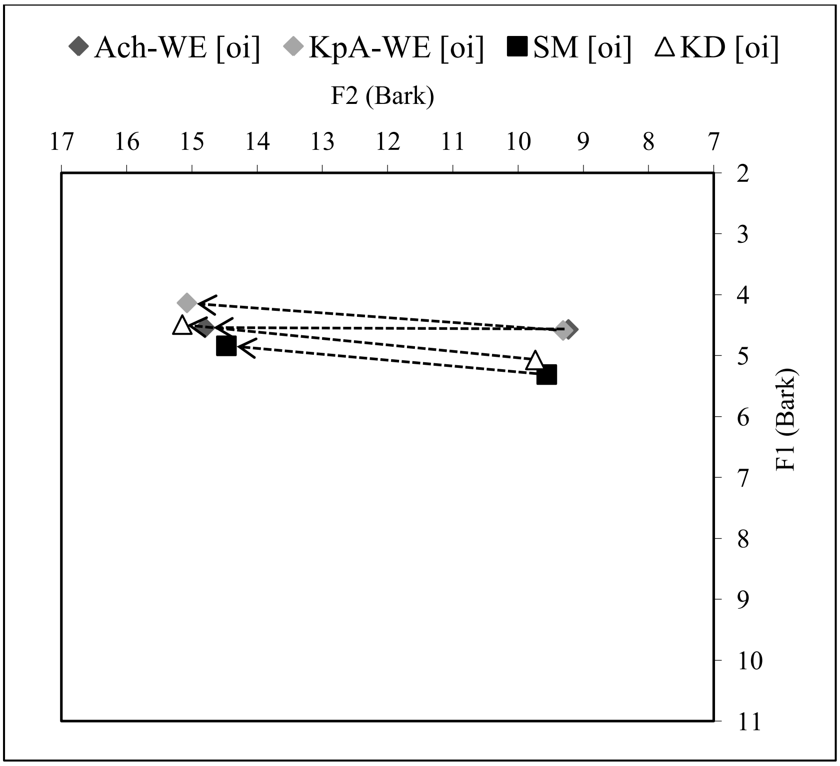


Figure 6.40: Trajectories of [oi] from Ach-WE, KpA-WE, SM and KD

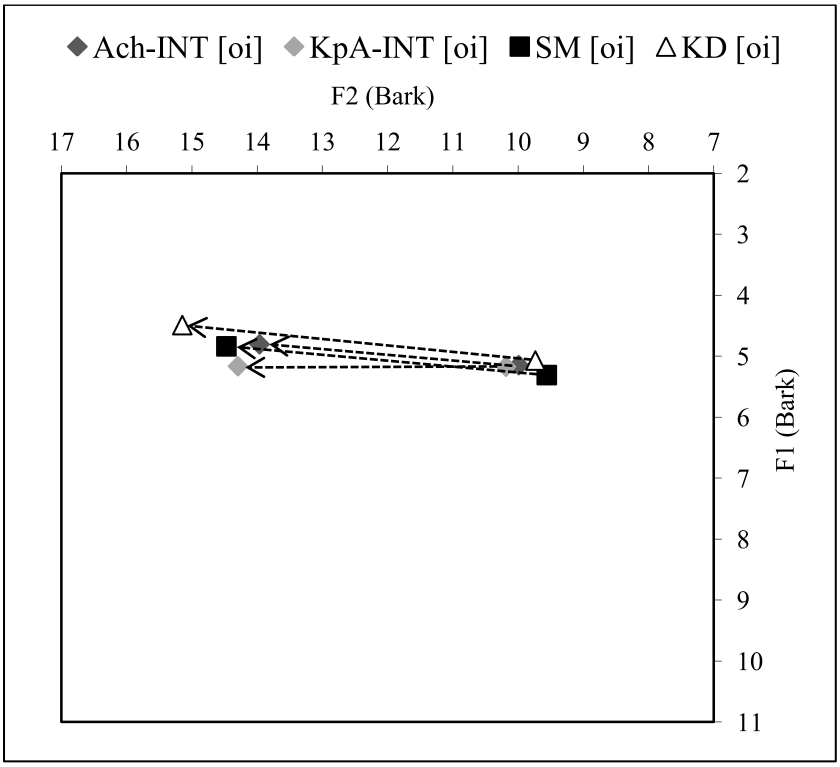


Figure 6.41: Trajectories of [oi] from Ach-INT, KpA-INT, SM and KD

6.4 Motivations for Sound Change and Maintenance

In the previous sections, the similarities and differences between Acehnese vowel productions in KpA with SM and KD vowels were presented. Further similarities and differences with Acehnese vowel productions in Ach were also mentioned. While it can be understood that Acehnese vowels maintained by KpA language consultants for the most part were related to the ones similar to SM and KD, such as /i/, /e/, /a/, and /o/. For /ɛ/ and /ɔ/, KpA language consultants also produced them with the same quality as the equivalent vowels with KD language consultants. The vowel /u/, however, was closer to the production by Ach language consultants compared to SM and KD language consultants. Still, it was found that KpA language consultants maintained vowels like /ɯ/ in Acehnese even if they did not exist in SM or KD. Despite being present in Malaysia, this sound survived in the Acehnese spoken in Kedah. However, there were also sounds in the Acehnese by KpA language consultant that were not realized by Ach language consultants. These sounds were /ɑ/, the realization of /ə/ closer to [ɵ], the loss of /ʌ/ that was replaced with [ɛ] or [ɔ] depending on the word environments (see 4.3.3.6), and other diphthongs that were realized differently (see 5.2.2 and 5.3.2). Most of the diphthongs produced by Ach language consultants were also not produced by KpA language consultants, except for [ai] and [oi] as they share similar productions with both SM and KD language consultants and [ui] that are produced similarly with KD language consultants. These vowels can be said to be what distinguish the speech of KpA language consultants as a group; they function as a part of their 'group-identification tools' (Trudgill, 1974, as cited in Tan, 2012, p. 573).

After the first Acehnese settlers came to live permanently in KpA and became isolated from their original Acehnese language community, it would be expected that over time effects from the local SM and KD would arise from countless single or group interactions. Especially since Acehnese speakers in KpA were small in number compared to the majority of SM and KD speakers; this influenced their language as a result from contact with the local dialect. The Acehnese speakers in KpA were conscious of their Acehnese being different than that of the one spoken in Aceh province. To illustrate this, the following is the reaction put forward by KpA5:

(E8) *Seuteungoh-seuteungoh h'ana meuphôm//seuteungoh kan//basa Acèh sidéh kamoe na h'ana meuphôm...nyang kamoe marit sinoe awak nyan na sit h'ana meuphôm.*
'I don't understand half (of the Acehnese from Aceh province when spoken to me)//just half//there is some Acehnese that we don't understand...the one that we speak here there is some that they don't understand'.
[KpA5 from INT at recording time: 382.831 sec to 389.805 sec]

The language contact with SM and KD could be expected to cause some changes in the Acehnese spoken in KpA. It was observed that Kerswill's (2001) description of koinéization for Acehnese speakers in KpA did not apply and neither did the tabula rasa new dialect formations of post-Colonial Englishes, such as the variation of English spoken in New Zealand (see, e.g., Trudgill, 2004). On koinéization, Kerswill says that for a koiné to form, the speakers must waive their previous allegiance and social divisions to show mutual solidarity (Kerswill, 2001, p. 673). However, in KpA, it was found that the speakers still had an important general sense of origin of their roots, or pride in being of Acehnese descents. The community still felt as if they were connected to, and part of, their Acehnese heritage. In order to maintain their allegiance with their Acehnese heritage, they referred KpA to as their home, and Aceh province as their *kampong* ‘village’ or origin. Furthermore, this position was also supported by the way they referred to themselves as Acehnese when interacting with other ethnic groups in Malaysia or as Acehnese Malaysians when they were in contact with Acehnese from the province. Therefore, even though their allegiance to Malaysia was beyond question, their connection to Aceh remained.

As mentioned previously, Trudgill (1974, as cited in Tan, 2012) says that the identity of an ethnic group can be indicated by the different variety of language that it speaks. To further investigate how the construction of identity manifested in sound change and maintenance by Acehnese speakers in KpA, the next section presents their personal comments about Acehnese usage among their family members and community in KpA to understand and interpret their linguistic variation as suggested by Llamas (2007). It is further stated by Llamas (2007, p. 596) that the way speakers describe their ‘self-definitions’ reflect the locally constructed speech community’s related orientation.

6.4.1 The Use of Acehnese in KpA

As revealed by Yusuf, Pillai and Mohd. Ali (2013), 64.4% of Acehnese descents in KpA still used Acehnese as their mother tongue at home. It was the choice for communication among family members and among other villagers of Acehnese descents as well. The language consultants in this study also agreed that the preservation of Acehnese was very important to avoid the demise of their heritage language.

6.4.1.1 Acehnese at Home and in the Community

The language consultants informed that at least until the fifth generation, every Acehnese descent in KpA had acquired Acehnese as their first language, as the use of this language was quite dominant at home and in the community. Hence, the family domain played an influential role in the acquisition of Acehnese for children and extended family or kinship groups. KpA1, KpA6 and KpA8 explained the use of Acehnese in KpA as:

(E9) *Dari ubit kan memang marit basa Acèh.* 'Since we were little we have spoken Acehnese'.

[KpA1 from INT at recording time: 594.693 sec to 596.684 sec]

(E10) *H'ana Melayu//biasa marit Acèh sabé//dari ubit kan marit Acèh.* 'We don't speak Malay at home//we are used to always speaking Acehnese//since we were little we speak Acehnese'.

[KpA6 from INT at recording time: 460.068 sec to 465.066 sec]

(E11) *Meunyo ureueng Malaysia nyoe marit Melayu/Malaysia lah kan/meunyo sama-sama Acèh h'antom marit Melayu/ h'antom marit basa laén/mandum marit Acèh.* 'The Malaysian people here speak Malay/Bahasa Malaysia right/if among Acehnese people we never speak Malay/never speak other languages/everyone speaks Acehnese'.

[KpA8 from INT at recording time: 151.354 sec to 160.704 sec]

KpA4 and KpA5 claimed that they had only learned Malay at the age of seven upon entering schools in the 1960s. KpA6 further described her situation in the early 1950s when she first entered elementary school. During those times, the teachers in her school were already aware that children from KpA were dominantly Acehnese speakers in their homes and community. This required the teachers to speak Malay to these children in slower speed to enable them to understand.

(E12) *Kamoe mandum h'an jeuet marit Melayu* <u>masa</u> *ubit-ubit//Thôn-thôn enam puluhan...ka ta-beuet* <u>cekgu</u> *dilèe marit beuleuheun-beuleuheun/meulèk-meulèk nah.* 'We couldn't speak Malay when we were little//In the 1960s...when we attended school the teacher had to first speak Malay slowly to us/yes very slowly'.

[KpA4 from INT at recording time: 397.585 sec to 426.121 sec]

(E13) *Di rumoh basa Acèh ta-kheun/meunyo jak sikula nyan keunong marit Melayu.* 'At home we speak Acehnese/but when we go to school then we must speak Malay'.

[KpA5 from INT at recording time: 648.564 sec to 655.539 sec]

(E14) *Jak sikula marit/marit Melayu//cit kadang-kadang 'oh* <u>cekgu</u> *tanyong marit basa Acèh* (laughs)*//cekgu meuphôm//cekgu ka biasa.* 'In school we spoke/spoke Malay/sometimes when the teacher asked me I answered in Acehnese (laughs)//but the teacher understood//the teacher was used to us doing this'.

[KpA6 from INT at recording time: 469.951 sec to 480.573 sec]

For some of those language consultants who had children married to Malays and still resided in KpA, they maintained Acehnese in the home even when their in-laws were around. It was anticipated that that by doing so, their Malay in-laws could grasp the language. There was a tendency for children to speak more Acehnese if there were relatives of Acehnese descents living with them in the house, such as grandparents, aunts, uncles, etc. As said by KpA4:

(E15) *Aneuk lôn//aneuk lôn gètnyan ngon aneuk na sit geu-meututô basa Acèh//peureumoh gètnyan ureueng Melayu/marit Melayu/tapi basa Acèh jeuet* *sikrak-krak.* 'My son//my son he too sometimes speaks Acehnese with his children//his wife is a Malay/speaks Malay/but can speak a few words of Acehnese.'

[KpA4 from INT at recording time: 732.786 sec to 743.628 sec]

6.4.1.2 The Role of Parents

The heritage of the parents also played a great role in determining that Acehnese became the children's first language at home. Therefore, if both mother and father were of Acehnese descents, then it was expected that their children would acquire Acehnese as their mother tongue. As explained by KpA3:

(E16) *Kamoe saréng marit basa Acèh//ngon aneuk lôn pih lôn marit basa Acèh/h'ana rôh* <u>Bahasa</u>*//jinoe aneuk lôn marit ngon cuco lôn pih basa Acèh…Ayah ngon mak lôn ureueng Acèh.* 'We always speak Acehnese//with my children I also speak Acehnese/there is no Malay among us//now my children with my grandchildren also speak Acehnese…My father and mother are Acehnese'.

[KpA3 from INT at recording time: 520.468 sec to 553.411 sec]

For language consultants who had grandchildren, such as KpA3, KpA4, KpA8 and KpA9, they tried their best to speak Acehnese with their grandchildren whenever they came and stayed in the village during the holidays. Even though it was just to get them to be familiar with one or two words in Acehnese. These language consultants felt that it was very important for their grandchildren to know at least some Acehnese. As said by KpA3:

(E17) *"Watèe uroe raya ramè yang woe u gampông//bak yak meureumpok ureueng syik awak nyan…uroe raya puasa yang ramè woe…meunyo ka meusapat/marit* *biasa Acèh mandum//*keliling *basa Acèh mandum."* During (the) holydays many (of us) return to (the) village//for (them to) meet their parents…(the) fasting holidays most (of them) return…when (we) gather/(we) all speak Acehnese//all around us we hear (people speaking) Acehnese.

[KpA3 from INT at recording time: 855.553 sec to 865.865 sec]

KpA9 even insisted in teaching her in-laws Acehnese by always speaking Acehnese to them even though they communicated with her in Malay.

(E18) *Geu marit Acèh* suka-suka *awaknyan/na geu-peugah peu-peu//watèe getnyan marit Kedah/lôn marit Acèh.* (They) speak Acehnese (the way) they like/(they) do speak many things (to me)//by using Kedah (dialect)/I reply (in) Acehnese.

[KpA9 from INT at recording time: 836.014 sec to 841.583 sec]

6.4.2 Sense of Acehnese Identity

As reported by Yusuf, Pillai and Mohd. Ali (2013), a strong sense of Acehnese identity is still seen among Acehnese descents in KpA despite them being born, raised and living in Malaysia. Stories by KpA language consultants revealed their sense of pride towards their ancestors who were Acehnese warriors who fled from Aceh due to Dutch occupation in their land. KpA7 said that they fled to Malaysia to escape from being killed by the Dutch and not for economic reasons. According to KpA1, their ancestors had managed to buy much of the land in KpA and its nearby villages to open up rubber and pepper plantations. The first generation of Acehnese who came to Kedah were known to be noble religious leaders and wealthy village chiefs from Aceh. As explained by KpA7:

(E19) *Awak nyan plueng bak Belanda/mandum plueng/jak mita teumpat hinoe kan/mandum pejuang.* 'They ran away from the Dutch/everyone fled/(they) went to find a (safer) place to live/everyone (was a) warrior.'

[KpA7 from INT at recording time: 806.435 sec to 814.495 sec]

The impression above was also found in the street names in KpA, where the names of ancestors of the first generation who established the village were used. Among them were Tengku di Balee, Tgk. Syik Lampoh U and Ampon Paya. Some buildings and schools also preserved their names, such as the meeting hall of Abu Bakar Nyak Cut and Dewan Abu Syik, the porch of Jambo Chut Ngoh Nyak Yek Abu Shik and the public school of Haji Nyak Gam.

It was believed that the previous strong ties of the language consultants' ancestors towards their homeland shaped their sense of Acehnese identity, which could be seen in the way that they referred to themselves as Acehnese when interacting with other speakers to show their identity. These acts defined their sense of self and were made to distinguish themselves with others (Llamas, 2007). Following Gumperz (1982), it was also observed that there was a tendency for the language consultants to regard Acehnese speakers as the "we code" and the majority language speakers of SM and KD as the "they code" (see 2.6.1.2). The examples of these identifications were expressed in the following excerpts. All expressions of identity in this section are capitalized.

(E20) *Ureueng luwa teuka yak bloe (asam sunti) keunoe//ureueng Melayu pih na,* UREUENG ACÈH *pih na.* 'Outsiders come and buy (*asam sunti*) from us…they are the Malays and also us Acehnese (from other villages)'

[KpA1 from INT at recording time: 869.821 sec to 879.385 sec]

(E21) *(Jih) meukawén ngon ureueng sinoe* UREUENG ACÈH. '(She) married with someone from here/an Acehnese.'

[KpA2 from INT at recording time: 784.816 sec to 786.640 sec]

(E22) *Lintô pih* UREUENG ACÈH (SINOE). 'My husband is also an Acehnese (from here).'

[KpA4 from INT at recording time: 387.654 sec to 388.669 sec]

(E23) *Mandum ji-meu'ah ngon tanyoe/ji-hormat tanyoe* UREUENG ACÈH DARI MALAYSIA*/dari Malaya kan/'a lagèe nyan.* 'Everyone shook hands with us/they respected us as Acehnese from Malaysia/from Malaya right/yes such as that.

[KpA4 from INT at recording time: 173.551 sec to 174.999 sec]

Referring to themselves as Acehnese as their indication of identity also distinguished them from the Malays, whom they referred to as *ureueng Malaysia nyoe* 'these Malaysian people', *ureueng Malaya/ureueng Melayu* 'Malays', *ureueng laén* 'other people' or *awak nyan* 'them' as expressed in the excerpts below:

(E24) *Meunyo* UREUENG MALAYSIA NYOE *marit Melayu/Malaysia lah kan/meunyo sama-sama Acèh h'antom marit Melayu/ h'antom marit basa laén/mandum marit Acèh.* 'The Malaysian people here speak Malay/Bahasa Malaysia right/if among Acehnese people we never speak Malay/never speak other languages/everyone speaks Acehnese'.

[KpA8 from INT at recording time: 151.354 sec to 160.704 sec]

(E25) *Peurumoh gobnyan ureueng/*UREUENG MALAYA/UREUENG MELAYU.

'His wife is a/a Malay/a Malay'.

[KpA4 from INT at recording time: 735.532 sec to 739.404 sec]

(E26) *I Yan nyoe/ na* UREUENG LAÉN *na/*UREUENG MELAYU *le/ka duek inoe.*

'In Yan, there are also other people/there are many Malays/that have resided here'.

[KpA5 from INT at recording time: 674.398 sec to 677.095 sec]

(E27) MELAYU *'a/*AWAK NYAN *hana meuphôm (Basa Acèh).* ''A the Malays/they don't understand (Acehnese language)'.

[KpA6 from INT at recording time: 673.252 sec to 675.529 sec]

Yusuf, Pillai and Mohd Ali (2013) also reported that even some younger villagers from the sixth generation still referred to themselves as TANYOE KETURUNAN ACÈH 'we are Acehnese descents' even though they were not that fluent in Acehnese compared to their parents. Yusuf, Pillai and Mohd Ali (2013) also described that when Acehnese descents in KpA interacted with other Acehnese speakers who were conscious of their heritage, then they identified themselves to them as Acehnese. Thus, when in contact with the Acehnese from Aceh province, then they referred to themselves as Acehnese Malaysians, which showed that they were carrying two identities as both Acehnese and Malaysians.

6.4.2.1 The Use of Titles in Names

Another way Acehnese descents in KpA identified themselves as distinct with other ethnic groups in Malaysia was by giving their children "Acehnese names for their children rather than Malay ones" (Yusuf, Pillai, Mohd. Ali, 2013, p. 54), such as the noble title *Cut* for girls and *Teuku* for boys. As mentioned earlier in 1.4.1, the ancestors of Acehnese descents in KpA were *ulamas* and *ulèebalangs* (see 1.4.1), who carried these titles. Therefore, some of these descents carried the traditions of giving names to their children with these titles.

6.4.2.2 Pride in the Heritage Language

There was pride among Acehnese descents in KpA that they were still able to speak Acehnese regardless of being born and raised in a different country. They said that they would interact in Acehnese with any Acehnese they met outside of the village. KpA5 and KpA6 recalled the time they went to Aceh province to meet their relatives that they had never met before.

(E28) *Ôh awak nyan//awak nyan h'ana patéh kamoe jeuet marit Acèh//ôh jeuet marit Acèh?/jeuet//pakon h'an jeuet?/ ureueng Acèh ...lheuh nyan barô marit Acèh.* 'Oh them//they couldn't believe we can speak Acehnese//oh you can speak Acehnese?/Yes I can//why not?/we are Acehnese...then we speak Acehnese together'.

[KpA5 from INT at recording time: 673.252 sec to 675.529 sec]

(E29) *Nyoe kampông Acèh mandum marit Acèh//aneuk miet pih…'A awak nyan hireuen pakon jeuet marit Acèh//seuteungoh-seuteungoh awak nyan h'ana marit lé Acèh//kadang-kadang aneuk miet yang teuka-teuka rombongan nyan h'an jeuet marit Acèh//sayang.* 'In Kampung Aceh, everyone speaks Acehnese//even the children…Yes they are astonished that we still could speak Acehnese//half of them don't speak Acehnese anymore//sometimes the Acehnese kids who visited our village in groups couldn't speak Acehnese//it's a pity'.

[KpA6 from INT at recording time: 706.517 sec to 711.325 sec and 787.031 sec to 798.989 sec]

The remarks made by KpA language consultants in E28 and E29 above showed the solidarity at play when they met Acehnese from the province; they wanted to be taken seriously as Acehnese themselves. In order to accomplish this, they tried to prove that they, too, could speak their heritage language despite the fact that they were born and raised in a different country.

6.4.3 Keeping Acehnese Alive

All of the language consultants asserted that they made their best effort to use Acehnese at home and with their community to encourage the use of Acehnese by younger generations despite being surrounded by a dominant community of SM and KD speakers. They did have concerns that Acehnese in their village would one day disappear. To pass on the cultural awareness of their Acehnese origin and traditions, the language consultants would frequently tell stories about their family and relatives in Aceh to their children. Even those who visited Aceh more than a couple of times, such as KpA1, KpA7 and KpA9, took their children (and grandchildren for KpA9) with them to further acknowledge their roots and ancestors. Aceh province was referred to as *kampông* 'village' by the language consultants as an implied reference to 'our origin', as told by KpA7:

(E30) *Lôn aneuk miet masa ubit-ubit/ka lheuh jak u Acèh teuka u Banda Acèh/Langsa/Samalanga/nyan asai nèk-nèk lôn//jadi awak nyan tupeu kan kiban kampông.* 'When my children were younger/I took them to visit Aceh we went to Banda Aceh/Langsa/Samalanga/those were the origins of my grandparents//so they know how the place we came from is like'.

[KpA7 from INT at recording time: 119.738 sec to 130.913 sec]

Their solidarity towards their own relatives and ethnic group in Aceh province and other Acehnese was still strong. In times of need, they were willing to collect money from everyone in the village to be able to take their people to visit their place of origin and help their own relatives and even other Acehnese they did not know to overcome disasters they experienced, such as the earthquake and tsunami that occurred on 26 December 2004. These attempts were assumed to have also led Acehnese descents in KpA to maintain their Acehnese in order to further uphold their relationships with their relatives in Aceh.

It was further observed that while the older generations were still preserving Acehnese in their daily conversations among each other, the younger generations, especially those from the sixth generation were more into mixing or switching to Malay among each other (Yusuf, Pillai & Mohd. Ali, 2013). The shifting of Acehnese to Malay was beginning to emerge within the youngest generation at the present time and more inter-marriage with non-Acehnese was speeding up the process.

In relation to this problem, Acehnese descents in KpA were making efforts to revive Acehnese in their community, as discussed in the following subsections.

6.4.3.1 Kampung Aceh Management Center

The Kampung Aceh Management Centre (KAMC) was launched in May 2005 in the village. This center provided seminar and recreational packages for everyone in Kedah and elsewhere in Malaysia. *Narit Geutanyo*, a newsletter written in Malay and

Acehnese, was published and distributed by KAMC every two months to the villagers. Its contents comprised of compiled news from Aceh province and from KpA, and information on religion and traditional Acehnese recipes were also presented. A section called ‘Belajar Bahasa Aceh’ (Learn Acehnese) was presented in every newsletter. Villagers also offered poems, stories or thoughts to be considered and published by the newsletter. Even though Acehnese was basically passed down orally to the next generation, the Acehnese descents in KpA said that they could read and write in Acehnese as this language was written in the Roman alphabet. Even though they said that most were struggling with the spelling conventions, they tried their best to write in Acehnese and later offered their writings to be published by *Narit Geutanyo*. On a daily basis, they always tried to text messages or write emails in Acehnese when communicating with other Acehnese. As Crystal (2000) advocates, making use of available technology is essential to keeping language visible among its speakers.

Acehnese books on poems, folklore, magazines/newspaper (written in Acehnese) and on Acehnese history (written in Bahasa Indonesia, Malay, Acehnese or English) given by relatives who visited from Aceh province or brought back by villagers after visits to the province were kept in KAMC and made available to villagers to borrow. Some Acehnese movies or songs were also available in KAMC. The language consultants stated that their children would watch the movies or listen to the songs just to accompany their parents; however, their children themselves preferred Malay or English movies or songs as they were more familiar to them because of exposure by the media.

6.4.3.2 Communal Announcements

The villagers also encouraged the daily sermons and announcements in the *meunasah* ‘small mosque’ Al-Irsyadi in KpA to be given by the imam or other elders in both

Acehnese and Malay. The *meunasah* functioned as a place to perform the five obligatory daily prayers, other religious services, village meetings, festivities and other public events. R6 informed that:

(E31) *Lam meunasah sabé-sabé Acèh marit Acèh lah/man nyoe pengumuman jampu-jampu bacut//'a Melayu pih le sit/sinan awak Melayu pih jak seumayang.* 'In the local mosque at the village among Acehnese we speak Acehnese language to each other/however if there are announcements the languages are mixed a little//yes with the Malays also praying there/because the mosque here is also visited by the Malay people to pray'.

[KpA6 from INT at recording time: 675.529 sec to 687.261 sec]

6.5 Conclusion

The acoustic descriptions of SM and KD vowels are presented in this chapter. The production of /i/, /e/, /a/ /u/ and /o/ in KpA was found to be produced similarly with SM and KD. We can say that many of the monophthong oral vowels produced by KpA language consultants had similar qualities to SM and KD vowels. There were also those that were produced differently, such as /ə/ that was found to be produced closer to [ɵ] in the vowel space. Ach [ə] was in fact discovered to be produced in the same way as SM [ə] and KD [ə]. This can be seen in Figure 6.42 and Figure 6.43 that illustrate the F1 and F2 correspondence to vowel height and retraction produced by Ach and KpA language consultants from WE, SM and KD language consultants where each vowel produced by the four groups of language consultants is very close in height and retraction, except for /ə/ in Figure 6.43 where its F2 is much lower for KpA [ə] compared to Ach, SM and KD [ə].

Furthermore, t-tests between KpA Acehnese vowels from WE and KD showed no significant differences in the F1 correspondence (t(7)=0.95, p=0.187) and in the F2 correspondence (t(7)=0.49, p=0.320). This means that the vowels were similar in vowel height and retraction by both groups of speakers in this context. T-tests between KpA Acehnese vowels from WE and SM could not be conducted as they have different number of vowels in their inventories.

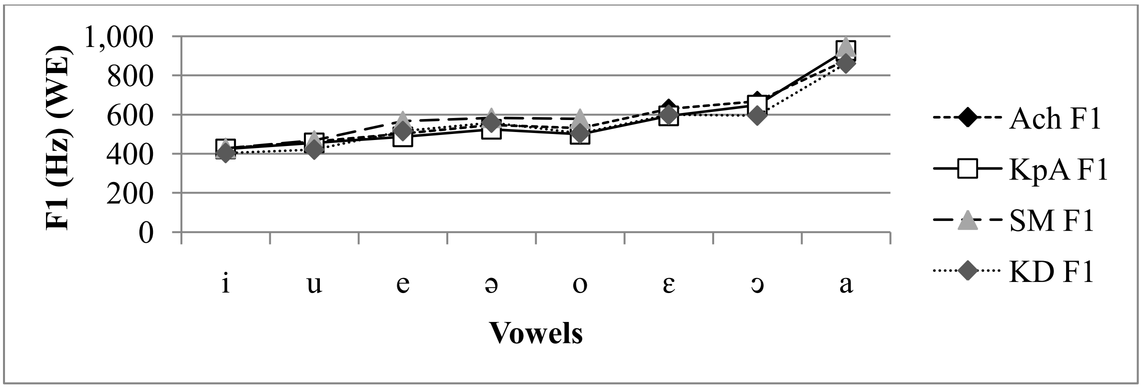


Figure 6.42: Correspondence of F1 from Ach-WE, KpA-WE, SM and KD monophthongs

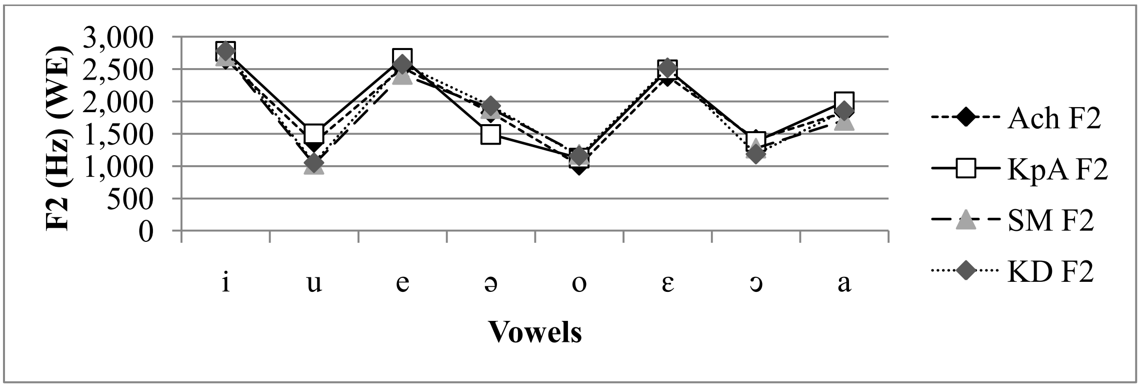


Figure 6.43: Correspondence of F2 from Ach-WE, KpA-WE, SM and KD monophthongs

Figure 6.44 and Figure 6.45 further illustrate the close correspondence of F1 and F2 to vowel height and retraction produced by Ach and KpA language consultants from INT, SM and KD language consultants. Again, the F2 average value of [ə] by KpA language consultants in Figure 6.45 is lower than Ach, SM and KD language consultants, indicating that KpA language consultants produced this vowel differently. T-tests were further conducted between KpA Acehnese vowels from INT and KD. The results showed no significant differences in the F1 correspondence ($t(7)=4.01$, $p=0.003$) and in the F2 correspondence ($t(7)=0.1$, $p=0.462$). This means that the vowels were also similar in vowel height and retraction by both groups of speakers in this context. T-tests between KpA Acehnese vowels from INT and SM could not be conducted as they have different number of vowels in their inventories.

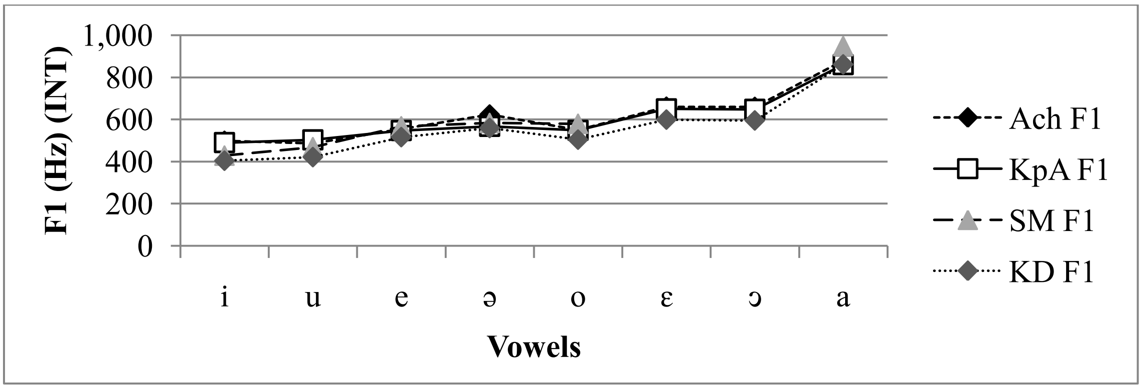


Figure 6.44: Correspondence of F1 from Ach-INT, KpA-INT, SM and KD monophthongs

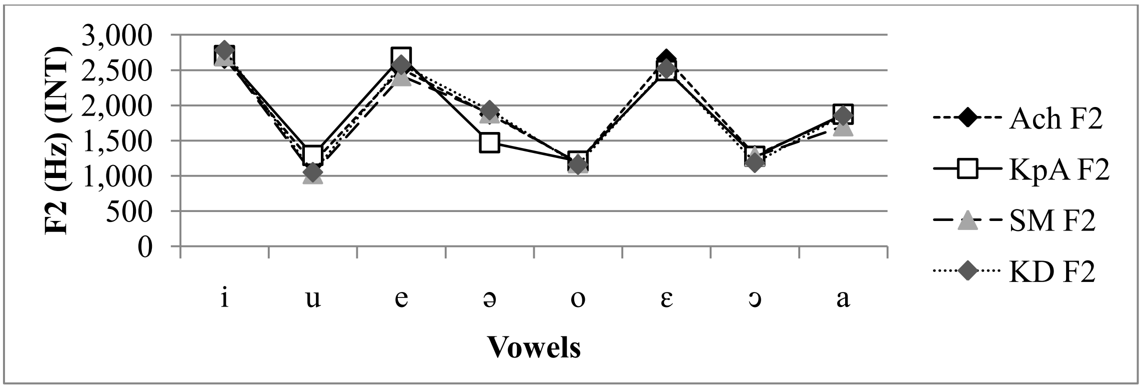


Figure 6.45: Correspondence of F2 from Ach-INT, KpA-INT, SM and KD monophthongs

Furthermore, the diphthongs /ai/, /ui/ and /oi/ were the only diphthongs maintained by KpA language consultants (see CHAPTER 5); this was also presumed to be related to its close productions with SM and KD as presented in this chapter.

The motives for KpA language consultants' sound change and maintenance were seen from their attitudes of Acehnese language use, identity and their efforts to revitalize their mother tongue. From KpA language consultants' sense of self, they did not just consider themselves as Acehnese, but as Acehnese Malaysian as well. Their perception of this identity could be recognized from their Acehnese where some sounds were produced differently from Ach.

CHAPTER 7 : DISCUSSION

7.1 Acehnese Monophthongs in Ach and KpA

Looking at the production of monophthongs investigated from the two speaking contexts, WE and INT, a pattern occurred in the production of vowels in WE, where most vowels in this set of data were produced higher than INT, such as [i], [e], [ɯ], [ə], [ʌ], [u], and [ɔ] for Ach language consultants (see Figure 4.1 and Figure 4.24), and [i], [e], [ɯ], [ɵ], [a], [u], [o] and [ɔ] for KpA language consultants (see Figure 4.8 and Figure 4.29). This is in accordance with Li and So (2006) and Ferguson and Kewley-Port (2007) (see 2.5.1), who state that the clear speaking mode (or WE in this present study) causes higher mean values of fundamental frequency of the monophthongs compared to conversational speech (or INT in this present study). Furthermore, longer vowel durations were also found in WE compared to INT. From WE, the average vowel duration for Ach language consultants was 0.162 sec and for KpA language consultants was 0.164 sec. These durations were shorter from INT (0.102 sec was found for vowels produced by Ach language consultants and 0.105 sec was found for vowels produced by KpA language consultants). T-test between the two speaking contexts by Ach language consultants showed a significant difference in the average vowel durations ($t(3500)=18.06$, $p<.0001$). Another t-test between the two speaking contexts by KpA language consultants showed a significant difference in the average vowel durations as well ($t(2731)=15.41$, $p<.0001$). These t-tests further confirmed the differences in terms of vowel durations between citation and spontaneous speech.

Additionally, the vowels in INT were more centralized in the articulatory acoustic vowel space compared to WE for both Ach and KpA language consultants. Different contexts used in extracting these vowels could have caused these different results. The larger vowel space areas in WE compared to INT are shown in Figure 7.1 for Ach monophthongs in WE (ED = 2.12) and INT (ED = 2.12). However, a t-test between the two speaking contexts by Ach language consultants showed no significant difference in vowel dispersion ($t(9)=0.06$, $p=0.477$). Furthermore, ED for KpA monophthongs in WE was 2.32, which was larger than in INT at 2.22. This is further illustrated in Figure 7.2 where the vowel space for KpA monophthongs in WE is larger than INT. However, a t-test between the two speaking contexts by KpA language consultants also showed no significant difference of vowel dispersion ($t(9)=0.3$, $p=0.385$).

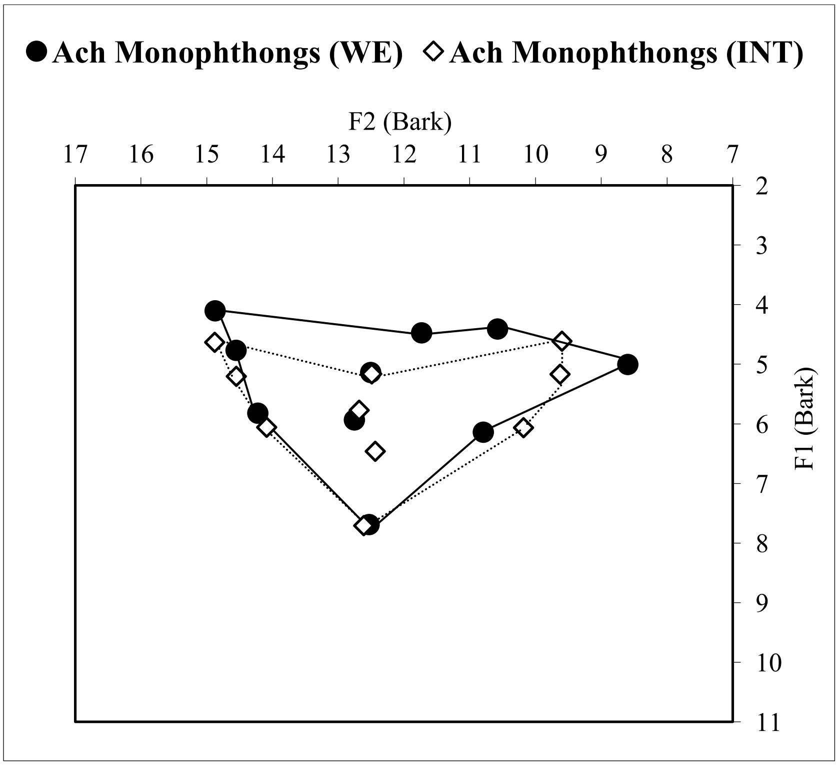


Figure 7.1: The vowel space of Acehnese vowels in Ach from WE and INT

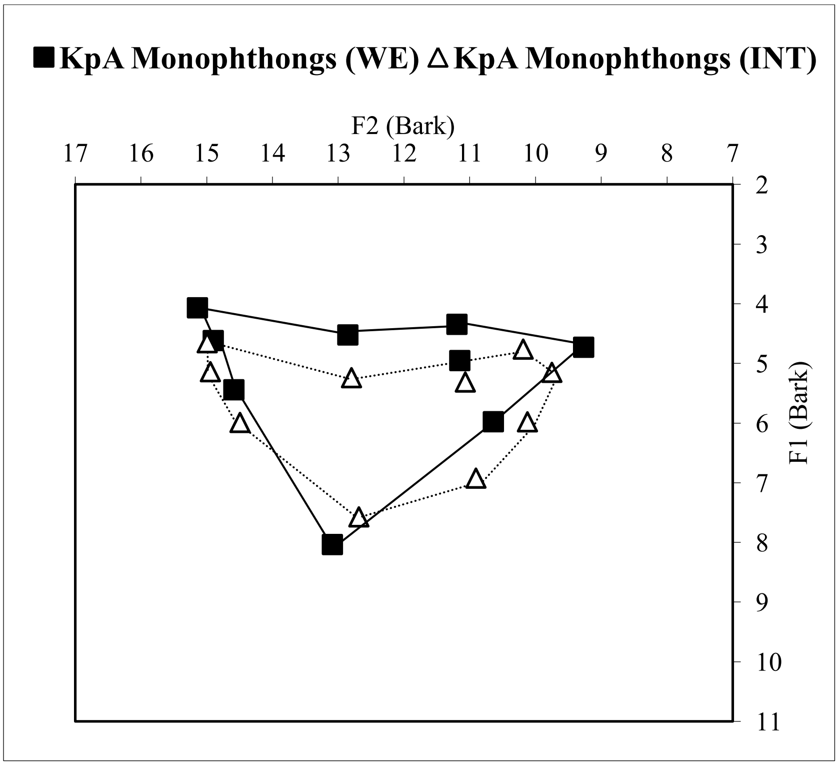


Figure 7.2: The vowel space of Acehnese vowels in KpA from WE and INT

Furthermore, the findings from INT also support the findings from WE. Based on WE, it was found that language consultants, Ach5 and Ach8, produced the sound /ʌ/ in *göt* as [ɛ]. However, both of these language consultants produced all instances of *göt* in INT with [ʌ]. What can be explained here is that conversational speech presents a more natural data compared to articulated citation speech (Deterding, 1997). In WE collection, with the interviewer questioning and waiting for them to produce the correct word, this situation had caused the setting to be more formal for the language consultants. The focus on the target words might have caused them to produce the words more consciously and deliberately with slower speed (Ferguson and Kewley-Port, 2007). The different sound produced by Ach5 and Ach8 for *göt* in WE could be due to their anxiety in producing the correct word as expected by the interviewer, and this made them to produce the word ‘wrongly’ instead. In INT, however, the setting between the language consultants and the interviewer was quite informal. The language consultants were allowed to present their thoughts and experiences on the topic given, therefore, their speech could be said to be produced more spontaneously. In conclusion, INT had complemented the findings from WE.

As can be seen in Figure 7.3, the vowel space occupied by Ach and KpA vowels from WE is quite similar. A t-test confirms this as the result showed no significant difference in vowel dispersion (t(9)=0.9, p=0.196). This means that the vowels produced by the two groups of language consultants in this speaking context were spread similarly in the vowel space.

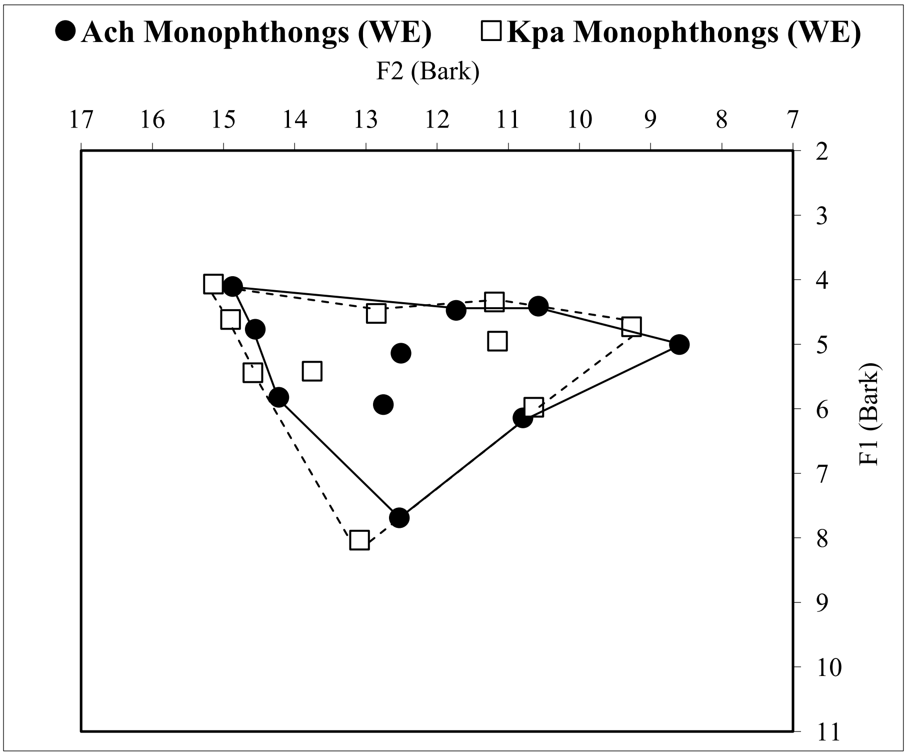


Figure 7.3: The vowel space of Acehnese vowels in Ach and KpA from WE

Furthermore, Figure 7.4 also shows that the vowel space occupied by Ach and KpA vowels from INT is rather similar. A t-test confirms this as the result showed no significant difference in vowel dispersion (t(9)=0.46, p=0.328). This suggests that the vowels produced by these language consultants in this speaking context were spread similarly in the vowel space.

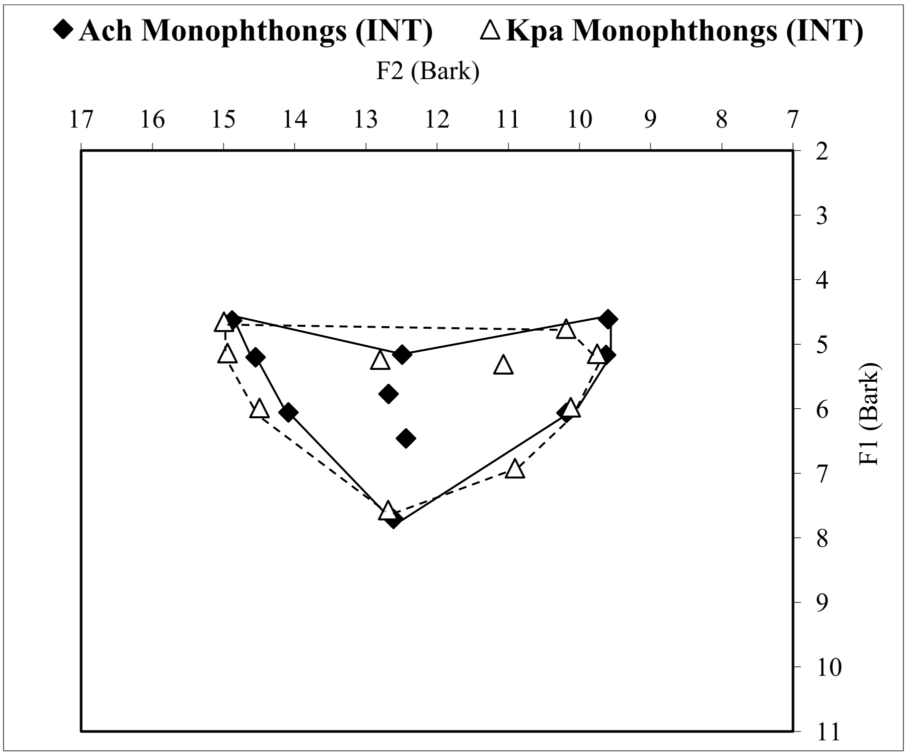


Figure 7.4: The vowel space of Acehnese vowels in Ach and KpA from INT

7.2 Acehnese Diphthongs in Ach and KpA

Similar to the production of monophthongs from WE, a pattern was also observed in the production of diphthongs where most vowels in WE were produced with more movement than INT, such as [iə], [ɯə], [uə], [ʌə], [ɔə], [ui], [əi], [oi] and [ai] for Ach language consultants (see Figure 5.1, Figure 5.2, Figure 5.22 and Figure 5.23), and [ɯə], [uə], [ɔə], [ui], [oi] and [ai] for KpA language consultants (see Figure 5.3, Figure 5.4, Figure 5.24 and Figure 5.25). According to Gay (1968) (see 2.5.3), the end points of the diphthong are usually not reached at fast speaking rate, and this could be the cause for the lesser movement of diphthongs in INT. Spontaneous speech in INT was presumed to be faster compared to WE where the articulations of language consultants were slower. Again, longer vowel durations were also found in the diphthongs from WE compared to INT. From WE, the average vowel durations for Ach language consultants was 0.179 sec and for KpA language consultants was 0.182 sec. From INT, the average durations were found to be shorter for the vowels, with 0.090 sec by Ach language consultants and 0.098 sec by KpA language consultants. A t-test between the diphthongs produced from WE and INT further confirms the obvious different average durations as the result showed a significant difference ($t(2064)=30.45$, $p<.0001$).

7.3 Effects from Standard Malay and Kedah Dialect

Taking into account that KpA language consultants were all multilingual speakers of Acehnese, KD, SM and English, this study took a further look into the changes of their Acehnese vowels in the relation to contact with SM and KD as these two languages were the ones they were more exposed to in their daily lives as Malaysian citizens. As a possible result of language contact, particular features were observed. These included the replacement of one speech sound with another, the loss of the affected sound, and the introduction of a new sound where in the previously original Acehnese inventory was none.

In KpA, the language consultants of this study who were of the fourth generation grew up learning Acehnese but they had limited access to L1 models as they acquired their Acehnese from elders than were also Malaysian. Following Kerswill (2010), the changes in sounds in KpA existing speech community can be said as a case of new variety formation.

7.3.1 Effects on the Monophthongs

The contact with SM and KD could result in some Acehnese monophthongs to be produced differently by KpA language consultants. On the basis of data presented in CHAPTER 4 and CHAPTER 5, this study presents evidence that most Acehnese monophthongs largely maintained in KpA were /i/, /e/, /ɛ/, /ɯ/, /a/, /u/, /o/ and /ɔ/. Based on the findings in CHAPTER 6, most of this sound maintenance could be due their similar productions with SM and KD, such as /i/, /e/, /a/, and /o/. The vowels /ɛ/ and /ɔ/ by KpA language consultants were also produced in the same way as KD language consultants. The sound /u/ was produced similarly with Ach language consultants, which was produced more fronted in the vowel space compared to SM and KD [u].

There was also only one sound that did not occur in SM and KD, which is /ɯ/ but was still maintained by KpA language consultants. It was produced more fronted by KpA language consultants compared to Ach language consultants from WE (see 4.2.3.4), but it was produced similarly by both group of language consultants in INT (see 4.3.3.4). Nonetheless, Acehnese speakers in KpA also acquired some new phonetic features of Acehnese after long language contact. From the data, evidence showed different productions of /ʌ/ and /ə/ compared to the ones produced by Acehnese speakers in Ach. The sound /ʌ/ had been replaced by [ɛ] and [ɔ]; depending on word environments in which they occurred and perhaps this was also because both SM and KD do not have this vowel in their inventories (see 2.4.1.1 and 2.4.2.1). The sound /ə/ by Ach language consultants was also seen to be realized much closer to the back [ɵ] by KpA language consultants in its vowel inventory as shown in Figure 4.12 and Figure 4.31.

Furthermore, the sound /ɑ/, which was seen to emerge in KpA, does not exist in the vowel inventory of SM and KD.

7.3.2 Effects on the Diphthongs

Only three Acehnese diphthongs were maintained by KpA language consultants, namely /ui/, /oi/ and /ai/. Based on the findings in CHAPTER 6, it was possible that SM and KD facilitated in the preservation of these diphthongs as they also exist in SM and KD. These sounds were also similarly produced by KpA, SM and KD language consultants. Accordingly, most of the centering diphthongs that were realized as monophthongs of the onset segments involved such as /iə/ to [i], /ɯə/ to [ɯ], /uə/ to [u], and /ɛə/ to [ɛ] may be explained by the fact that SM and KD do not contain centering diphthongs.

The vowels that were seen to be moving away from KpA were mostly centering diphthongs in Acehnese. For one, this type of diphthong is not present in both SM and KD, respectively, and this might have caused their shift or lost. The realization of /əi/ to [oi] further showed that the onset /ə/ was drifting to the back of the vowel space with lower F2 average value, as found in its monophthong production where it was also realized more back, suggesting [ɵ]. This sound was seen to emerge both in the monophthong and diphthong counterparts for KpA language consultants. There were also the realization of /ʌi/ to be closer to [ɔe], and /ɔi/ to be closer to [oe].

7.3.3 Sense of Identity

The sense of self that KpA language consultants' verbalized to define their identity as not just Acehnese, but also as Acehnese Malaysian, delineated their ethnic group membership among other ethnics in Malaysia and even those Acehnese from Aceh province. Based on the findings of their vowel production in this study, this in-group membership was signalled through the use of their Acehnese variety, where specific sounds were produced differently from those by Ach language consultants. It was possible that the sound /ɯ/ that exists in Acehnese but not in SM and KD was maintained perhaps to define their 'Acehnese' identity. New sounds in their variety classified their specific 'Acehnese in-group' identity from other groups of Acehnese speakers, whilst those sounds that were not preserved described their 'Acehnese Malaysian' identity. Consequently, the production of sound similarities between KpA group members and different sound productions from other group members categorized their local speech community.

Languages is continually in flux rather than static (Mufwene, 2007), which means that they are not fixed, and as a result, neither are identities. As time passes, Acehnese descents in KpA are expected to keep on performing a collection of identities that continually shift (Joseph, 2010). To adjust to various audiences and social contexts in their multiple speech communities that they belong to empower their use and choice of language to constantly change depending on circumstances. As a reflection, languages with which speakers strongly identify can persevere; on the other hand, languages to which speakers identify weakly, or languages whose associated identity becomes neutralized can easily undergo change or even disappear (Appel & Muysken, 1987, as cited in Ratte, 2011, p. 23).

Acehnese descents in KpA, despite still having the identity of still referring themselves as Acehnese Malaysians, the elder members of the community also had apprehension about the loss of the language in the years to come (Yusuf, Pillai and Mohd. Ali, 2013). It is a more common phenomenon that younger generations in KpA leave the village to further pursue better education and employment elsewhere in the country and also overseas. This will surely lead to fewer interactions with speakers of Acehnese and a further decrease in the use of Acehnese in their daily life. As explained by Yusuf, Pillai and Mohd. Ali (2013, p, 58), the fear by Acehnese descents in KpA might be associated to "competing identities: a state-defined identity versus one with a historical link to a neighbouring region; an identity that affords particular rights and privileges versus one that is linked to one's culture and heritage."

Efforts are of course taken by the elders to uphold their mother tongue by constantly using it to their younger relatives at home and among other Acehnese in the village. This conscious effort is seen to encourage other members of their community to keep Acehnese alive in KpA. Nevertheless, although the second to the fourth generations of Acehnese descents in KpA are still using Acehnese and exert to promote its continuation, the fifth and the sixth generations are the one to decide whether Acehnese shall continue to survive or whether the community will surrender to the demands of KD in Kedah and SM as the official language in Malaysia.

For the time being, the motivation to use Acehnese is rooted from the positive attitudes and identity towards the language that persisted in the community. The steady contribution from the Acehnese speakers who came to visit them regularly may encourage the survival of Acehnese. On the other hand, when the need to speak Acehnese is gone, if attitudes towards its usage are altered, and if younger generations are further acculturated into mainstream society, and then Acehnese will become an endangered minority language in Malaysia that may be lost in KpA in the generations to come.

CHAPTER 8 : CONCLUSION

8.1 Introduction

This chapter presents the conclusion of the findings from the oral monophthongs and diphthongs produced by Ach and KpA language consultants in this study, and their similarities with SM and KD.

8.2 Research Question 1: What are the characteristics of the oral monophthongs and diphthongs in the Acehnese language used by speakers in Ach and KpA based on their acoustic properties?

In summary, both Ach and KpA language consultants produced the vowels [i], [e], [ɛ], [u] and [ɔ] similarly. The vowel charts for Acehnese vowels in Ach and KpA showed that [ɯ], [a] and [o] were produced more open and fronted by KpA language consultants compared to Ach language consultants. From WE, two vowels were found to be produced differently by KpA language consultants, namely /e/ and /ʌ/. The vowel /e/ was also produced further back and the vowel /ʌ/ in *göt* was found to be produced in [ɛ] (27 tokens) and [ɔ] (3 tokens).

Moreover, the findings from INT coincided with WE that the oral monophthong vowels still largely maintained by KpA language consultants were /i/, /e/, /ɛ/, /ɯ/, /a/, /u/, /o/ and /ɔ/. Again, the productions of /ə/ and /ʌ/ were discovered not to correspond to the description of these vowels in the Ach variety. INT and WE both corresponded to /ə/ being realized as [ɵ] by KpA language consultants. Furthermore, the realization of /ʌ/

was absent in the KpA variety. From INT, it was also found that /ʌ/ was realized as [ɛ] and [ɔ]; depending on the word environment they appeared in. Furthermore, INT detected the emerging sound /ɑ/ in the KpA variety that was not found in WE.

Table 8.1 summarizes the Acehnese monophthongs inventory from both groups of language consultants.

Table 8.1: Ach and KpA Monophthongs

No	Monophthongs	Ach	KpA
1	i	✓	✓
2	e	✓	✓
3	ɛ	✓	✓
4	ɯ	✓	✓
5	ə	✓	X → ([ɵ])
6	ʌ	✓	X → ([ɛ] and [ɔ])
7	a	✓	✓
8	ɑ	X	✓
9	u	✓	✓
10	o	✓	✓
11	ɔ	✓	✓
Total		10	10

n.b. ✓ = present in the study
X = absent in the study
(….) = realized as the vowel in parenthesis

From WE, it was found that Ach language consultants produced diphthongs /ʌə/ and /ɔə/ with their offsets moving to high back positions, closer to [ʌu] and [ɔu], rather than to the center of the vowel space. The rest of the other diphthongs were generally maintained, namely /iə/, /ɛə/, /ɯə/, /uə/, /ui/, /əi/, /oi/, /ʌi/, /ɔi/ and /ai/.

The findings from INT further corresponded to the findings from WE for Ach diphthongs, where /iə/, /ɛə/, /ɯə/, /uə/, /ui/, /əi/, /oi/ and /ai/ were maintained by the speakers. It also confirmed the production of /ʌə/ and /ɔə/ to be moving towards the back of the vowel space, realized as [ʌu] and [ɔu] from both speaking contexts. As for /ʌi/ and /ɔi/, no additional information was found from INT as they were absent in the selected word environments under study.

More changes appeared in the production of vowels by KpA language consultants from WE where only three diphthongs were maintained, which were /ui/, /oi/ and /ai/. Thus, five were realized differently than expected based on Asyik's inventory. The diphthong /ɯə/ was found to be produced closer to [ɯɨ] and /uə/ was found to be produced closer to [uɯ]. The diphthongs in the words *dhöe* and *toe* were realized as [ɔo], the diphthong in the word *hei* was realized as [oi], the diphthong in the word *lagöina* was realized as [ɔe], and lastly, the diphthong in the word *poih* was realized as [oe]. There were also two diphthongs in Asyik's inventory that appeared to be produced as monophthongs of the onset segment involved. These diphthongs are /iə/ that was realized as [i] and /ɛə/ that was realized as [ɛː].

Furthermore, more monophthongisation of diphthongs by KpA language consultants from INT were found, and this included the monophthongisation of the onset segment involved from the diphthongs /iə/, /ɯə/, /uə/, and /ɛə/ to be realized as [i], [ɯ], [u] and [ɛ]. Similar to WE, all instances of /əi/ in *hei* in INT were also realized as [oi]. The diphthongs /ui/, /oi/ and /ai/ were all presented in INT. However, /ɔə/ that was found to be produced as [ɔo] in WE, were conserved as [ɔə] in INT, therefore, it can be presupposed that KpA language consultants did maintain this diphthong in their speech. Nevertheless, no further examination could be conducted on the production of /ʌə/, /ʌi/ and /ɔi/ as they were absent in INT in the selected word environments for this study.

Table 8.2 summarizes the Acehnese diphthongs inventory from both groups of language consultants.

Table 8.2: Ach and KpA Diphthongs

No	Diphthongs	Ach	KpA
1	iə	✓	([i])
2	ɯə	✓	([ɯ])
3	uə	✓	([u])
4	ɛə	✓	([ɛ])
5	ʌə	([ʌu])	([ɔo])
6	ɔə	([ɔu])	✓
7	ui	✓	✓
8	əi	✓	([oi])
9	oi	✓	([oi])
10	ʌi	✓	([ɔe])
11	ɔi	✓	([oe])
12	ai	✓	✓
Total		12	7

n.b. ✓ = present in the study
X = absent in the study
(….) = realized as the vowel in parenthesis

8.3 Research Question 2: What are the similarities and differences between the vowel inventories and characteristics of Acehnese in Ach and KpA based on their acoustic properties?

For monophthongs, it was found that both language consultants from both contexts produced only /i/, /e/, /ɛ/, /u/ and /ɔ/ similarly, whilst /ɯ/, /a/ and /o/ were produced more fronted by KpA language consultants in WE and similar to those vowels produced by Ach language consultants in INT. The sound /ə/, however, was realized further back by KpA language consultants in both WE and INT, suggesting [ɵ]. KpA language consultants did not realize the sound /ʌ/ in both speaking contexts. This sound was realized as either [ɛ] or [ɔ], depending on word environment. Table 8.3 below demonstrates the similarities and differences between Acehnese monophthongs in WE and INT from both groups of language consultants.

Table 8.3: Similarities and differences of Ach and KpA monophthongs production from WE and INT

<table>
<tr><th rowspan="2">Vowel</th><th colspan="2">WE</th><th colspan="2">INT</th></tr>
<tr><th>Ach</th><th>KpA</th><th>Ach</th><th>KpA</th></tr>
<tr><td>i</td><td colspan="2">Similar</td><td colspan="2">Similar</td></tr>
<tr><td>e</td><td colspan="2">Similar</td><td colspan="2">Similar</td></tr>
<tr><td>ɛ</td><td colspan="2">Similar</td><td colspan="2">Similar</td></tr>
<tr><td>ɯ</td><td></td><td>More fronted</td><td colspan="2">Similar</td></tr>
<tr><td rowspan="2">ə</td><td colspan="2">Different</td><td colspan="2">Different</td></tr>
<tr><td>[ə]</td><td>More back, realized closer to [ɵ]</td><td>[ə]</td><td>More back, realized closer to [ɵ]</td></tr>
<tr><td rowspan="2">ʌ</td><td colspan="2">Different</td><td colspan="2">Different</td></tr>
<tr><td>[ʌ]</td><td>[ɛ] and [ɔ]</td><td>[ʌ]</td><td>[ɛ] and [ɔ], depending on word environment</td></tr>
<tr><td>a</td><td></td><td>More fronted</td><td colspan="2">Similar</td></tr>
<tr><td>u</td><td colspan="2">Similar</td><td colspan="2">Similar</td></tr>
<tr><td>o</td><td></td><td>More fronted</td><td colspan="2">Similar</td></tr>
<tr><td>ɔ</td><td colspan="2">Similar</td><td colspan="2">Similar</td></tr>
</table>

For diphthongs, KpA language consultants maintained only /ai/, /ui/ and /oi/ and they were produced similarly with Ach /ai/, /ui/ and /oi/. KpA language consultants realized other diphthongs differently. Table 8.4 presents and summarizes the similarity and differences of the Acehnese diphthongs obtained in WE and INT from both group of language consultants.

Table 8.4: Similarities and differences of Ach and KpA diphthongs production from WE and INT

Vowel	WE		INT	
	Ach	KpA	Ach	KpA
iə	Different		Different	
	[iə]	[i]	[iə]	[i]
ɯə	Different		Different	
	[ɯə]	[ɯɨ]	[ɯə]	[ɯ]
uə	Different		Different	
	[uə]	[uɯ]	[uə]	[u]
ɛə	Different		Different	
	[ɛə]	[ɛː]	[ɛə]	[ɛ]
ʌə	Different		Unknown	
	[ʌu]	[ɔo]	[ʌu]	Not found.
ɔə	Different		Different	
	[ɔu]	[ɔo]	[ɔu]	[ɔə]
ui	Similar		Similar	
əi	Different		Different	
	[əi]	[oi]	[əi]	[oi]
oi	Similar		Similar	
ʌi	Different		Unknown	
	[ʌi]	[ɔe]	Not found.	Not found
ɔi	Different		Unknown	
	[ɔe]	[oe]	Not found.	Not found.
ai	Similar		Similar	

Based on Table 8.4, it was apparent that there was more variability in the production of diphthongs compared to monophthongs by KpA language consultants, especially in centering diphthongs. As explained in 2.5.3, rising diphthongs glide from a more open to a less open tongue position and this makes them more distinct. Centering diphthongs, however, are less distinct because it begins with a more peripheral vowel and ends with a more central one. Therefore, they are more susceptible to reductions and assimilations (Balas, 2009). This might have been another driving force for centering diphthong to be produced differently by KpA language consultants despite also being absent in SM and KD diphthongs.

8.4 Research Question 3: To what extent are the vowels in KpA similar and different to SM and KD?

From the measurements and comparisons of /i/, /e/, /ɛ/, /ə/, /a/, /u/, /o/ and /ɔ/ between KpA, SM and KD language consultants, it was found that most of these monophthongs were produced similarly with SM and KD. In detail, KpA [i], [e], [a], and [o] shared the same qualities with equivalent vowels in SM and KD. For KpA [ɛ] and [ɔ], they had similar qualities with those from KD. As for [u], Ach and KpA language consultants produced this sound similarly where it was more fronted in the vowel space compared to SM and KD. The diphthongs [ai] and [oi] by KpA language consultants were also produced similarly with SM and KD. Furthermore, both KpA and KD language consultants produced [ui] similarly.

Table 8.5 below demonstrates the similarities and differences between the production of Acehnese vowels in Ach and KpA with SM and KD vowels.

Table 8.5: A summary of similarities and differences between the Acehnese variety in Ach and KpA with SM and KD vowels

Vowel	Acehnese in Ach	Acehnese in KpA	SM	KD
i	Similar	Similar	Similar	Similar
e	Similar	Similar	Similar	Similar
ɛ	Similar	Similar	(Absent)	Similar
ə	Similar	More back	Similar	Similar
a	Similar	Similar	Similar	Similar
u	Similar	Similar	More back	More back
o	Similar	Similar	Similar	Similar
ɔ	Similar	Similar	(Absent)	Similar
ai	Similar	Similar	Similar	Similar
ui	Similar	Similar	(Absent)	Similar
oi	Similar	Similar	Similar	Similar

The sound changes and maintenance by KpA language consultants were linked to their identity that was still resolute within their community. This identity caused them to maintain their mother tongue when interacting with other Acehnese speech communities, either in Malaysia or those visiting them from Aceh, despite being relatively distant from their ancestor's home region in Aceh. Based on the information gained from INT, KpA language consultants took weight in the importance of education and building good relationships with their Malay extended families, friends and neighbors. Therefore, the demand on the use of more SM and KD to fulfil these needs have inevitable influenced their Acehnese and eventually led to unavoidable sound changes.

8.5 Recommendations for Future Work

Due to its scope and limitations, this present study would like to suggest the following recommendations for future research.

Despite this present study having presented the acoustic properties of the Acehnese oral vowels in Ach and KpA varieties, the results were based on vowels that occurred within CVC or CV environments where C was generally stops or fricatives to attain better measurements from the formants in PRAAT. These specific structures have provided numerous findings; among them the existence of /ɑ/ and /ɵ/ by KpA language consultants that is not found in the vowel inventory of Acehnese in Ach variety and the changes in the production of some Acehnese diphthongs. For this reason, this present study suggests the analysis of an even larger data set to investigate vowels that may appear in other environments. Additionally, future research should also consider examining other Acehnese speakers' perception to listen to the target words used in this study to indicate the vowel they hear from Acehnese speakers in KpA.

Furthermore, this present study only examined the oral monophthongs and diphthongs in Acehnese. This language is also known to consist of nasal monophthongs and diphthongs (see 2.3.1). Future research on the study of the acoustic properties and characteristics of these vowels are deeply encouraged.

The discussion on vowel harmony for /ɑ/ in 4.3.3.7 was based on the data extracted from this present study and the samples provided were very limited. Further studies from larger data should be conducted to substantiate these pilot findings.

It is well known that formant values are affected by gender differences. This study only employed female language consultants as it focused on the comparison of Acehnese that is spoken in two different areas. However, it is suggested that measurements of vowels from males could be included for future studies that study the Acehnese vowels to further investigate the characteristics of the vowels produced by both males and females.

A study on the production of Acehnese vowels from generation to generation by Acehnese speakers in Ach and in KpA is suggested to study the changes that may have occurred over time. Since Acehnese is spoken in both Ach and KpA as their mother tongue in the midst of other local and national languages (e.g. Bahasa Malaysia in KpA and Bahasa Indonesia in Ach), therefore, influences from these languages can also be explored.

To further extend the nature of language contact occurring in KpA, studies that explore into the speakers' sense of identity, investigate their style shift (e.g. when talking to older and younger family members), and examine into the presence of any effects of speaker sex are also encouraged in the future.

In summary, this preliminary study introduced some changes occurring in the production of Acehnese vowels in KpA. The data from this study showed that a new Acehnese variety was emerging in KpA, Kedah. The comparable data from SM and KD provided was limited due to the time and funding limitations of this study, which were time and funding. There remains more work to be done and certain aspects to be improved upon to provide a better comparative illustration of vowel productions in the Acehnese spoken in Ach and KpA and to further understand the similarities and differences of vowel qualities between the Acehnese in KpA, SM and KD. Therefore, for future research, it is suggested that SM and KD are investigated in other contexts such as continuous speech to explore in more depth the influences they may have on the Acehnese spoken by Acehnese descents in KpA.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

List of Publications:

Academic Journals:

1. Pillai, S. & Yusuf, Y. Q. (2012). An instrumental study of Acehnese oral vowels. *Language and Linguistics, 13*(6), 1029-1050.
2. Yusuf, Y. Q., Pillai, S. & Mohd. Ali, N. T. A. (2013). Speaking Acehnese in Malaysia. *Language & Communication, 33*(1), 50-60.
3. Yusuf, Y. Q. & Pillai, S. (2013). Acoustic description of diphthongs in two varieties of Acehnese. *Pertanika Journal of Social Sciences and Humanities, 21*(S), 153-168.

Conference Proceedings:

1. Yusuf, Y. Q. & Pillai, S. (2012). An instrumental analysis of Acehnese diphthongs produced in Kampung Aceh, Kedah, *Proceedings of the UKM International Conference on Linguistics.* Universiti Kebangsaan Malaysia, Malaysia (pp. 1-6).

Conference/Seminar Presentations:

1. An acoustic study of monophthong vowels in two varieties of Acehnese (co-authored with Stefanie Pillai), *2nd Postgraduate Conference, Faculty of Languages and Linguistics*, University of Malaya, Malaysia, 9-10 December, 2010.
2. An instrumental study of oral diphthong vowels in two varieties of Acehnese (co-authored with Stefanie Pillai), *The 3rd FLL Postgraduate Conference:*

Studies on Languages and Linguistics, University of Malaya, Malaysia, 8 – 9 December 2011.

3. An instrumental analysis of Acehnese diphthongs produced in Kampung Aceh, Kedah (co-authored with Stefanie Pillai), *UKM International Conference on Linguistics*, Universiti Kebangsaan Malaysia, Malaysia, 10-11 April 2012.

LIST OF APPENDICES

APPENDIX A

Acehnese vowels in the North Aceh dialect from previous studies:

No	Vowel	Sulaiman, Jusuf, Hanum, Lani and Ali (1977)	Asyik (1972, 1987)	Durie (1985)
1	/i/	✓	✓	✓
2	/ɯ/	✓	✓	✓
3	/ɨ/	X	X	X
4	/u/	✓	✓	✓
5	/e/	✓	✓	✓
6	/ə/	✓	✓	X
7	/ɤ/	X	X	✓
8	/o/	✓	✓	✓
10	/ɛ/	✓	✓	✓
11	/ʌ/	✓	✓	✓
12	/ɔ/	✓	✓	✓
13	/a/	✓	✓	✓
14	/iə/	✓	✓	✓
15	/ɯə/	✓	✓	✓
16	/ɨə/	X	X	X
17	/uə/	✓	✓	✓
18	/ɛə/	✓	✓	✓
19	/ʌə/	X	✓	X
20	/oə/	✓	X	X
21	/ɔə/	✓	✓	✓
22	/ui/	✓	✓	X
23	/əi/	✓	✓	X
24	/oi/	✓	✓	X
25	/ʌi/	X	✓	X
26	/ɔi/	X	✓	X
27	/ai/	✓	✓	X
28	/ĩ/	✓	✓	✓
29	/ɯ̃/	✓	✓	✓
30	/ɨ̃/	X	X	X

‘Appendix A, continued’

31	/ũ/	✓	✓	✓
32	/ɛ̃/	✓	✓	✓
33	/ʌ̃/	X	✓	✓
34	/ɔ̃/	✓	✓	✓
35	/ã/	✓	✓	✓
36	/ĩə/	✓	✓	✓
37	/ɯ̃ə/	✓	✓	✓
38	/ɨ̃ə/	X	X	X
39	/ũə/	✓	✓	✓
40	/ɛ̃ə/	✓	✓	✓
41	/ɔ̃ə/	X	X	✓
42	/ãɪ/	✓	✓	X
Total		30 vowels	34 vowels	27 vowels

n.b. ✓ = present in the study
X = absent in the study

APPENDIX B

The transcription conventions are adapted from Giampapa (2001):

Transcription Conventions	
/	Short pause
//	Long pause of more than a few seconds
[...]	Overlapping talk
IDENTITY	Capitals used for emphasis
(...)	Author’s addition
_	Interrupted talk
…	Continuing talk
Words	Acehnese
<u>Words</u>	Standard Malay or Kedah Dialect

APPENDIX C

Word List for Acehnese:

TARGET WORD	TARGET PHONEME	GLOSS
cit	/i/	too, also
peut	/ɯ/	four
cut	/u/	small, title for women of noble descent
pét	/e/	close/shut the eyes
tet	/ə/	burn
pôt	/o/	blow, to fan
cèt	/ɛ/	paint
göt	/ʌ/	good, fine
cop	/ɔ/	sew
pat	/a/	where
tiep	/iə/	every, each
beuet	/ɯə/	study, learn
buet	/uə/	work, job, action
kèe	/ɛə/	I, me, mine (informal, impolite form)
dhöe	/ʌə/	clogged up
toe	/ɔə/	near
bui	/ui/	pig
hei	/əi/	to call
bhôi	/oi/	sponge cake
lagöina	/ʌi/	very
poih	/ɔi/	mail, post
jai	/ai/	many, much

APPENDIX D

Pictures to assist data collection in WE[1]:

1. To extract *cit* 'too, also':

2. To extract *peut* 'four':

3. To extract *cut* 'small, title for women of noble descent':

4. To extract *pét* 'close/shut the eyes':

[1] All of the pictures were retrieved from www.fotosearch.com

5. To extract *tet* ‘burn’:

6. To extract *pôt* ‘blow, to fan’:

7. To extract *cèt* ‘paint’:

8. To extract *göt* ‘good, fine’:

9. To extract *cop* ‘sew’:

10. To extract *pat* ‘where’:

11. To extract *tiep* ‘every, each’:

12. To extract *beuet* ‘study, learn’:

ai04935 www.fotosearch.com

13. To extract *buet* ‘work, job, action’:

14. To extract *kèe* ‘I, me, mine (informal, impolite form)’:

15. To extract *dhöe* ‘clogged up’:

px349004 www.fotosearch.com

16. To extract *toe* ‘near’:

17. To extract *bui* ‘pig’:

18. To extract *hei* ‘to call’:

19. To extract *bhôi* ‘sponge cake’:

065954 www.fotosearch.com

20. To extract *lagöina* ‘very’:

21. To extract *poih* ‘mail, post’:

22. To extract *jai* ‘many, much’:

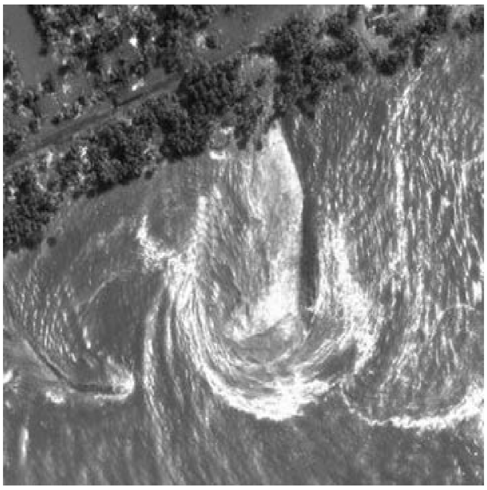
APPENDIX E

Pictures to assist INT data collection:

Picture 1:

Picture 2:

Picture 3:



Picture 4:

Picture 5:

Picture 6:

Picture 7:

Picture 8:

Picture 9:

APPENDIX F

Date

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

Dear Madam,

My name is Yunisrina Qismullah Yusuf, and I am a PhD student at the University of Malaya in Kuala Lumpur. The research I wish to conduct for my Doctoral thesis is to explore the Acehnese oral vowel productions by the Acehnese speakers in Kampung Aceh, Malaysia and Aceh, Indonesia, therefore it involves recording on the sounds produced by Acehnese speakers. This project will be conducted under the supervision of Associate Professor Dr. Stefanie Shamila Pillai.

The research proposal has already been approved by University of Malaya and is attached for your attention. I am hereby seeking your consent to conduct some recordings from you. Your name will remain anonymous and referred to as only a code number in my thesis and in any related papers intended for publication. If you require any further information, please do not hesitate to contact me at my cell phone number: +60162904704, or email: yunisrina@gmail.com. Thank you for your time and consideration in this matter. I truly appreciate it.

Yours sincerely,

Yunisrina Qismullah Yusuf
Matrix No: THA 070028
University of Malaya

Please complete the bottom portion of this letter and return it to me.

Name : ____
Signature : ____
Date : ____

I am willing to participate in this research project.
YES ____ NO ____

APPENDIX G

Information and Consent Form for SM and KD speakers:

Speaker Number	Name	Age	Ethnicity	Gender	Hometown (where they grew up and lived till the age of 15)	List in order: L1, L2, L3, etc	Laguae/dialect spoken at home	Phone No. & Email	Date of recording
01									
02									
03									
04									
05									
06									

APPENDIX H

Word List for Standard Malay:

TARGET WORD	**TARGET PHONEME**	**GLOSS**
Pita	/i/	tape, ribbon
Beta	/e/	I, me (for royalty)
Peta	/ə/	map
Batu	/a/	rock
buta	/u/	blind
Kota	/o/	city
lambai	/ai/	wave
kerbau	/au/	buffalo
amboi	/oi/	expression of surprise

APPENDIX I

Word List for Kedah Dialect:

TARGET WORD	**TARGET PHONEME**	**GLOSS**
Pita	/i/	tape, ribbon
Beta	/e/	I, me (for royalty)
bebeh	/ɛ/	small, title for women of noble descent
Peta	/ə/	map
Batu	/a/	rock
buta	/u/	blind
Kota	/o/	city
bodong	/ɔ/	a group of fish
lambai	/ai/	wave
kerbau	/au/	buffalo
Bui	/ui/	give, offer
amboi	/oi/	expression of surprise

APPENDIX J

Ach monophthongs measurements in average values from WE:

J.1 Ach /i/ from *cit* [ʧit] 'too, also'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.124	452	2567	4.31	14.67
Ach2	3	0.154	428	2686	4.10	14.95
Ach3	3	0.211	391	2900	3.76	15.40
Ach4	3	0.122	443	2654	4.24	14.87
Ach5	3	0.157	448	2705	4.28	14.99
Ach6	3	0.154	455	2637	4.34	14.83
Ach7	3	0.095	442	2543	4.23	14.61
Ach8	3	0.103	421	2589	4.03	14.72
Ach9	3	0.255	391	2482	3.76	14.47
Ach10	3	0.180	416	2768	3.99	15.13
Total	30	0.155	429	2653	4.11	14.87
SD		0.05	27.73	130.08	0.25	0.29

J.2 Ach /e/ from *pét* [pet] 'close/shut the eyes'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.127	454	2460	4.33	14.41
Ach2	3	0.118	547	2469	5.14	14.43
Ach3	3	0.162	487	2729	4.62	15.04
Ach4	3	0.117	501	2579	4.75	14.70
Ach5	3	0.222	522	2624	4.92	14.80
Ach6	3	0.129	568	2419	5.31	14.31
Ach7	3	0.109	508	2403	4.81	14.27
Ach8	3	0.102	542	2479	5.10	14.46
Ach9	3	0.172	450	2520	4.30	14.56
Ach10	3	0.160	458	2495	4.36	14.50
Total	30	0.142	504	2518	4.77	14.55
SD		0.04	49.31	112.30	0.43	0.27

J.3 Ach /ɛ/ from *cèt* [ʧɛt] 'paint'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.122	576	2395	5.38	14.25
Ach2	3	0.144	673	2377	6.18	14.20

‘Appendix J.3, continued’

Ach3	3	0.161	552	2675	5.19	14.92
Ach4	3	0.132	631	2289	5.84	13.96
Ach5	3	0.229	597	2551	5.56	14.63
Ach6	3	0.143	692	2442	6.32	14.37
Ach7	3	0.139	664	2234	6.11	13.81
Ach8	3	0.127	611	2317	5.68	14.04
Ach9	3	0.193	600	2288	5.58	13.96
Ach10	3	0.193	694	2292	6.34	13.97
Total	30	0.158	629	2386	5.82	14.22
SD		0.04	52.82	141.79	0.43	0.36

J.4 Ach /ɯ/ from *peut* [pɯt] ‘four’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.152	442	1579	4.23	11.54
Ach2	3	0.149	502	1624	4.75	11.73
Ach3	3	0.258	495	1680	4.70	11.96
Ach4	3	0.151	458	1828	4.36	12.52
Ach5	3	0.199	523	1719	4.94	12.11
Ach6	3	0.168	483	1423	4.59	10.85
Ach7	3	0.139	535	1450	5.04	10.97
Ach8	3	0.173	446	1513	4.26	11.26
Ach9	3	0.188	390	1821	3.76	12.49
Ach10	3	0.194	427	1601	4.09	11.64
Total	30	0.177	470	1624	4.48	11.73
SD		0.040	50.31	154.32	0.44	0.63

J.5 Ach /ə/ from *tet* [tət] ‘burn’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.147	542	1646	5.10	11.82
Ach2	3	0.117	561	1908	5.26	12.80
Ach3	3	0.166	551	1657	5.18	11.87
Ach4	3	0.122	555	1866	5.21	12.65
Ach5	3	0.184	568	1868	5.32	12.66
Ach6	3	0.147	561	1966	5.26	12.99
Ach7	3	0.149	570	1816	5.33	12.47
Ach8	3	0.146	548	1706	5.15	12.06
Ach9	3	0.205	503	1942	4.76	12.91
Ach10	3	0.176	510	1873	4.82	12.68
Total	30	0.156	547	1825	5.14	12.51
SD		0.03	27.20	122.35	0.23	0.45

J.6 Ach /ʌ/ from *göt* [gʌt] 'good, fine'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.141	587	1646	5.48	11.82
Ach2	3	0.174	695	1881	6.35	12.70
Ach3	3	0.167	622	1805	5.77	12.44
Ach4	3	0.132	649	1550	5.98	11.42
Ach5*	(3)	(0.206)	(626)	(2592)	(5.80)	(14.73)
Ach6	3	0.142	690	1819	6.31	12.49
Ach7	3	0.114	665	1757	6.11	12.25
Ach8*	(3)	(0.151)	(596)	(2399)	(5.55)	(14.25)
Ach9	3	0.338	603	1801	5.61	12.42
Ach10	3	0.215	697	1700	6.37	12.04
Total	27	0.178	651	1745	6.00	12.21
SD		0.18	50.46	136.67	0.40	0.52

* /ʌ/ in *göt* realized closer to /ɛ/ and excluded from data

J.7 Ach /a/ from *pat* [pat] 'where'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.144	797	1838	7.12	12.55
Ach2	3	0.108	905	1890	7.89	12.74
Ach3	3	0.143	860	1844	7.57	12.58
Ach4	3	0.141	940	1831	8.12	12.53
Ach5	3	0.217	818	1828	7.27	12.52
Ach6	3	0.149	903	1960	7.87	12.97
Ach7	3	0.096	904	1816	7.88	12.47
Ach8	3	0.135	891	1726	7.79	12.14
Ach9	3	0.270	874	1829	7.67	12.52
Ach10	3	0.200	855	1803	7.54	12.43
Total	30	0.165	877	1831	7.69	12.53
SD		0.06	51.40	65.49	0.36	0.23

J.8 Ach /u/ from *cut* [ʧut] 'small, title for women of noble descent'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.419	450	1411	4.30	10.79
Ach2	3	0.121	487	1523	4.62	11.30
Ach3	3	0.222	506	1273	4.79	10.10
Ach4	3	0.111	426	1215	4.08	9.78
Ach5	3	0.216	482	1467	4.58	11.05

‘Appendix J.8, continued’

Ach6	3	0.116	496	1367	4.70	10.57
Ach7	3	0.120	450	1291	4.30	10.19
Ach8	3	0.125	477	1329	4.53	10.39
Ach9	3	0.272	417	1345	4.00	10.47
Ach10	3	0.154	437	1452	4.18	10.98
Total	30	0.188	463	1367	4.41	10.58
SD		0.16	37.95	114.82	0.34	0.56

J.9 Ach /o/ from *pôt* [pot] ‘blow, to fan’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.140	523	1129	4.94	9.30
Ach2	3	0.115	544	1092	5.11	9.08
Ach3	3	0.152	565	1098	5.30	9.11
Ach4	3	0.149	544	960	5.11	8.25
Ach5	3	0.215	541	1002	5.09	8.52
Ach6	3	0.141	528	914	4.98	7.94
Ach7	3	0.109	554	1063	5.20	8.91
Ach8	3	0.120	534	892	5.03	7.79
Ach9	3	0.254	469	953	4.46	8.21
Ach10	3	0.182	508	1031	4.81	8.71
Total	30	0.158	531	1013	5.01	8.60
SD		0.05	38.90	85.61	0.33	0.55

J.10 Ach /ɔ/ from *cop* [ʧɔp] ‘sew’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	3	0.129	622	1443	5.76	10.94
Ach2	3	0.099	701	1565	6.40	11.48
Ach3	3	0.173	701	1589	6.39	11.58
Ach4	3	0.117	687	1440	6.28	10.92
Ach5	3	0.186	621	1332	5.76	10.40
Ach6	3	0.134	701	1371	6.39	10.60
Ach7	3	0.113	704	1345	6.42	10.47
Ach8	3	0.143	660	1384	6.07	10.66
Ach9	3	0.220	636	1306	5.88	10.27
Ach10	3	0.186	656	1346	6.04	10.47
Total	30	0.150	669	1412	6.14	10.79
SD		0.04	43.49	113.26	0.35	0.53

APPENDIX K

KpA monophthongs measurements in average values from WE:

K.1 KpA /i/ from *cit* [ʧit] ‘too, also’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.167	417	2719	4.00	15.02
KpA2	3	0.132	411	2772	3.94	15.13
KpA3	3	0.125	409	3082	3.93	15.76
KpA4	3	0.156	440	2728	4.20	15.04
KpA5	3	0.131	413	2841	3.96	15.28
KpA6	3	0.109	413	2627	3.96	14.81
KpA7	3	0.136	413	2774	3.96	15.14
KpA8	3	0.133	431	2671	4.12	14.91
KpA9	3	0.169	453	2795	4.32	15.18
KpA10	3	0.158	445	2739	4.25	15.06
Total	30	0.142	424	2775	4.07	15.14
SD		0.03	21.30	126.67	0.19	0.26

K.2 KpA /e/ from *pét* [pet] ‘close/shut the eyes’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.185	495	2527	4.69	14.57
KpA2	3	0.182	506	2796	4.79	15.18
KpA3	3	0.162	493	2814	4.68	15.22
KpA4	3	0.181	488	2678	4.63	14.93
KpA5	3	0.169	506	2702	4.79	14.98
KpA6	3	0.170	465	2547	4.43	14.62
KpA7	3	0.158	503	2787	4.76	15.17
KpA8	3	0.161	464	2464	4.42	14.42
KpA9	3	0.143	462	2752	4.41	15.09
KpA10	3	0.132	480	2593	4.56	14.73
Total	30	0.164	486	2666	4.62	14.90
SD		0.03	28.05	129.06	0.25	0.30

K.3 KpA /ɛ/ from *cèt* [ʧɛt] ‘paint’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1*	(3)	0.199	842	2104	7.44	13.43
KpA2*	(3)	0.181	827	2107	7.34	13.44
KpA3*	(3)	0.151	853	2069	7.52	13.32

'Appendix K.3, continued'

KpA4*	(3)	0.127	900	2030	7.85	13.20
KpA5*	(3)	0.150	887	2175	7.76	13.64
KpA6*	(3)	0.142	773	2161	6.94	13.60
KpA7	3	0.171	653	2441	6.02	14.36
KpA8	3	0.142	584	2231	5.45	13.80
KpA9*	(3)	0.136	946	2054	8.16	13.28
KpA10*	(3)	0.112	774	2002	6.95	13.11
Total	6	0.111	580	2214	5.42	13.75
SD		0.04	41.24	174.40	0.34	0.45

* /ɛ/ from *cèt* realized as /a/ and excluded from data

K.4 KpA /ɯ/ from *peut* [pɯt] 'four'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.214	438	1907	4.19	12.80
KpA2	3	0.181	506	1952	4.79	12.95
KpA3	3	0.166	474	1854	4.51	12.61
KpA4	3	0.171	475	2054	4.52	13.28
KpA5	3	0.198	495	2107	4.69	13.44
KpA6	3	0.121	468	2001	4.46	13.11
KpA7	3	0.214	506	1814	4.79	12.47
KpA8	3	0.174	506	1734	4.79	12.17
KpA9	3	0.197	427	1972	4.09	13.01
KpA10	3	0.158	460	1846	4.39	12.58
Total	30	0.179	476	1924	4.52	12.85
SD		0.04	39.20	131.96	0.34	0.45

K.5 KpA /ə/ from *tet* [tət] 'burn'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.240	535	1417	5.04	10.82
KpA2	3	0.215	546	1388	5.13	10.68
KpA3	3	0.157	533	1732	5.02	12.16
KpA4	3	0.131	521	1534	4.92	11.35
KpA5	3	0.164	521	1478	4.92	11.10
KpA6	3	0.139	523	1550	4.93	11.42
KpA7	3	0.168	533	1441	5.02	10.93
KpA8	3	0.132	538	1400	5.07	10.74
KpA9	3	0.277	506	1360	4.79	10.54
KpA10	3	0.117	493	1594	4.68	11.61
Total	30	0.174	525	1489	4.95	11.15
SD		0.06	21.34	138.00	0.18	0.61

n.b. /ə/ in *tet* realized closer to /ɵ/.

K.6 KpA /ʌ/ from *göt* [gʌt] 'good, fine'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.254	622	2577	5.76	14.69
KpA2	3	0.231	560	2641	5.25	14.84
KpA3*	(3)	(0.187)	(613)	(1463)	(5.69)	(11.03)
KpA4	3	0.180	625	2427	5.79	14.33
KpA5	3	0.222	572	2574	5.35	14.69
KpA6	3	0.175	608	2401	5.65	14.26
KpA7	3	0.157	574	2681	5.37	14.93
KpA8	3	0.160	578	2294	5.40	13.98
KpA9	3	0.167	560	2694	5.25	14.96
KpA10	3	0.181	548	2496	5.15	14.50
Total	27	0.192	583	2532	5.44	14.59
SD		0.06	36.82	136.54	0.31	0.34

n.b. /ʌ/ in göt realized closer to /ɛ/.

*/ʌ/ in göt realized closer to /ɔ/ and excluded from data.

K.7 KpA /a/ from pat [pat] 'where'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.194	874	1986	7.67	13.06
KpA2	3	0.203	866	2000	7.62	13.10
KpA3	3	0.172	1093	2027	9.09	13.19
KpA4	3	0.189	893	2014	7.80	13.15
KpA5	3	0.154	979	2064	8.38	13.31
KpA6	3	0.136	853	1934	7.52	12.89
KpA7	3	0.174	971	2027	8.32	13.19
KpA8	3	0.192	853	1907	7.52	12.80
KpA9	3	0.159	1013	2041	8.59	13.23
KpA10	3	0.184	880	1951	7.71	12.94
Total	30	0.176	928	1995	8.04	13.09
SD		0.03	83.63	57.67	0.55	0.19

K.8 KpA /u/ from *cut* [ʧut] 'small, title for women of noble descent'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.190	427	1724	4.09	12.13
KpA2	3	0.148	439	1406	4.20	10.76
KpA3	3	0.133	448	1454	4.28	10.99
KpA4	3	0.148	482	1732	4.58	12.16

‘Appendix K.8, continued’

KpA5	3	0.177	485	1440	4.60	10.93
KpA6	3	0.137	466	1677	4.44	11.95
KpA7	3	0.216	479	1346	4.56	10.47
KpA8	3	0.163	461	1365	4.39	10.57
KpA9	3	0.163	426	1447	4.08	10.96
KpA10	3	0.137	441	1396	4.22	10.72
Total	30	0.161	455	1499	4.35	11.19
SD		0.03	32.79	162.44	0.29	0.71

K.9 KpA /o/ from *pôt* [pot] ‘blow, to fan’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.230	490	1196	4.65	9.68
KpA2	3	0.222	499	1026	4.72	8.68
KpA3	3	0.148	504	1222	4.77	9.82
KpA4	3	0.172	517	1058	4.89	8.87
KpA5	3	0.176	505	1068	4.78	8.93
KpA6	3	0.147	511	1207	4.83	9.74
KpA7	3	0.159	511	1080	4.83	9.01
KpA8	3	0.188	498	1186	4.72	9.63
KpA9	3	0.169	482	1106	4.58	9.16
KpA10	3	0.122	475	1087	4.52	9.05
Total	30	0.173	499	1124	4.73	9.27
SD		0.04	27.77	80.62	0.24	0.47

K.10 KpA /ɔ/ from *cop* [ʧɔp] ‘sew’

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	3	0.212	705	1433	6.43	10.89
KpA2	3	0.209	613	1373	5.69	10.61
KpA3	3	0.164	651	1350	6.00	10.49
KpA4	3	0.152	630	1320	5.83	10.34
KpA5	3	0.139	672	1461	6.17	11.02
KpA6	3	0.151	640	1440	5.91	10.93
KpA7	3	0.150	613	1279	5.69	10.13
KpA8	3	0.152	663	1363	6.10	10.55
KpA9	3	0.210	660	1357	6.07	10.53
KpA10	3	0.178	636	1427	5.88	10.86
Total	30	0.172	648	1380	5.98	10.64
SD		0.04	37.75	84.80	0.30	0.42

APPENDIX L

Ach monophthongs measurements in average values from INT:

L.1 Ach /i/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	61	0.098	486	2510	4.61	14.53
Ach2	51	0.094	507	2601	4.80	14.75
Ach3	15	0.106	501	2886	4.75	15.37
Ach4	34	0.098	501	2722	4.75	15.03
Ach5	45	0.124	506	2870	4.79	15.34
Ach6	44	0.111	491	2791	4.66	15.18
Ach7	89	0.085	490	2656	4.65	14.88
Ach8	64	0.074	473	2571	4.50	14.68
Ach9	24	0.100	421	2586	4.04	14.71
Ach10	41	0.06	533	2774	5.02	15.14
Total	468	0.094	489	2663	4.63	14.88
SD		0.05	42.83	167.68	0.38	0.38

L.2 Ach /e/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	55	0.101	545	2406	5.13	14.27
Ach2	54	0.111	553	2494	5.19	14.50
Ach3	29	0.145	541	2770	5.09	15.13
Ach4	46	0.098	556	2623	5.21	14.80
Ach5	20	0.110	559	2592	5.24	14.73
Ach6	21	0.101	541	2635	5.09	14.83
Ach7	51	0.096	563	2521	5.27	14.56
Ach8	66	0.090	565	2462	5.29	14.42
Ach9	17	0.096	533	2350	5.02	14.13
Ach10	51	0.090	562	2459	5.27	14.41
Total	410	0.102	555	2516	5.20	14.55
SD		0.05	26.40	172.04	0.22	0.42

L.3 Ach /ɛ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	14	0.100	627	2234	5.81	13.81
Ach2	12	0.089	663	2267	6.10	13.90
Ach3	4	0.118	693	2334	6.33	14.08

‘Appendix L3, continued’

Ach4	9	0.086	690	2321	6.31	14.05
Ach5	9	0.100	635	2476	5.87	14.45
Ach6	10	0.15	657	2514	6.05	14.54
Ach7	20	0.111	703	2290	6.41	13.97
Ach8	13	0.084	635	2319	5.87	14.04
Ach9	19	0.096	617	2336	5.73	14.09
Ach10	11	0.120	693	2370	6.33	14.18
Total	121	0.104	658	2335	6.06	14.09
SD		0.05	51.51	125.97	0.41	0.33

L.4 Ach /ɯ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	38	0.094	549	1841	5.16	12.57
Ach2	36	0.092	557	1862	5.23	12.64
Ach3	23	0.119	552	1936	5.18	12.89
Ach4	19	0.105	573	1780	5.36	12.34
Ach5	26	0.111	562	1888	5.27	12.73
Ach6	8	0.089	558	1819	5.23	12.48
Ach7	41	0.089	537	1722	5.05	12.12
Ach8	15	0.071	554	1790	5.20	12.38
Ach9	14	0.095	487	1765	4.63	12.29
Ach10	41	0.078	554	1802	5.20	12.42
Total	261	0.094	550	1820	5.16	12.49
SD		0.05	41.02	153.57	0.35	0.56

L.5 Ach /ə/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	1	0.086	613	1974	5.69	13.02
Ach2	Not found.					
Ach3	Not found.					
Ach4	Not found.					
Ach5	Not found.					
Ach6	2	0.135	613	1914	5.69	12.82
Ach7	5	0.060	629	1838	5.82	12.55
Ach8	Not found.					
Ach9	Not found.					
Ach10	Not found.					
Total	8	0.082	623	1874	5.77	12.68
SD		0.06	18.52	154.18	0.15	0.54

L.6 Ach /ʌ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	8	0.099	668	1849	6.13	12.59
Ach2	17	0.119	710	1797	6.46	12.40
Ach3	14	0.161	707	1880	6.44	12.70
Ach4	5	0.107	733	1838	6.64	12.55
Ach5	6	0.131	693	1874	6.33	12.68
Ach6	5	0.144	733	1854	6.64	12.61
Ach7	17	0.110	749	1767	6.77	12.29
Ach8	3	0.136	666	1694	6.12	12.01
Ach9	2	0.150	613	1854	5.69	12.61
Ach10	19	0.134	704	1745	6.41	12.21
Total	96	0.128	710	1806	6.46	12.44
SD		0.06	48.78	158.96	0.38	0.71

L.7 Ach /a/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	122	0.104	848	1865	7.49	12.65
Ach2	239	0.107	930	1890	8.05	12.74
Ach3	78	0.118	871	1850	7.65	12.60
Ach4	115	0.102	927	1847	8.03	12.58
Ach5	56	0.123	834	1853	7.39	12.61
Ach6	55	0.104	947	1874	8.16	12.68
Ach7	223	0.103	897	1897	7.83	12.76
Ach8	84	0.094	809	1785	7.21	12.36
Ach9	79	0.105	837	1755	7.41	12.25
Ach10	113	0.087	803	1805	7.16	12.43
Total	1164	0.104	880	1854	7.71	12.61
SD		0.05	87.81	123.20	0.59	0.45

L.8 Ach /u/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	14	0.096	484	1259	4.60	10.02
Ach2	12	0.113	483	1086	4.59	9.05
Ach3	8	0.150	488	1213	4.63	9.77
Ach4	10	0.094	505	1165	4.78	9.51
Ach5	17	0.122	509	1187	4.82	9.63
Ach6	22	0.099	477	1137	4.53	9.34
Ach7	24	0.084	481	1183	4.57	9.61

‘Appendix L.8, continued’

Ach8	14	0.064	487	1179	4.63	9.58
Ach9	4	0.097	443	1123	4.23	9.26
Ach10	7	0.062	476	1333	4.53	10.41
Total	132	0.097	486	1181	4.61	9.60
SD		0.05	40.30	134.09	0.35	0.74

L.9 Ach /o/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	17	0.161	538	1149	5.06	9.42
Ach2	18	0.083	555	1217	5.21	9.80
Ach3	31	0.114	550	1169	5.16	9.53
Ach4	17	0.104	549	1166	5.16	9.51
Ach5	22	0.114	553	1204	5.19	9.72
Ach6	8	0.116	548	1178	5.15	9.58
Ach7	47	0.095	545	1186	5.12	9.62
Ach8	9	0.092	551	1222	5.17	9.82
Ach9	3	0.125	573	1146	5.36	9.40
Ach10	38	0.096	558	1198	5.24	9.69
Total	210	0.106	550	1186	5.17	9.63
SD		0.05	26.76	109.32	0.23	0.61

L.10 Ach /ɔ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
Ach1	38	0.092	637	1281	5.89	10.14
Ach2	41	0.126	663	1311	6.09	10.29
Ach3	43	0.116	667	1334	6.13	10.41
Ach4	35	0.099	659	1219	6.06	9.81
Ach5	33	0.117	632	1287	5.85	10.17
Ach6	24	0.096	660	1271	6.07	10.09
Ach7	53	0.103	701	1330	6.40	10.39
Ach8	9	0.103	649	1342	5.98	10.45
Ach9	29	0.108	630	1177	5.83	9.57
Ach10	27	0.122	659	1329	6.06	10.38
Total	332	0.109	659	1289	6.07	10.18
SD		0.06	48.57	139.49	0.38	0.72

APPENDIX M

KpA monophthongs measurements in average values from INT:

M.1 KpA /i/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	40	0.089	477	2656	4.54	14.88
KpA2	15	0.116	488	2638	4.63	14.84
KpA3	20	0.106	509	3001	4.81	15.60
KpA4	22	0.115	504	2685	4.77	14.94
KpA5	19	0.140	491	2766	4.66	15.12
KpA6	21	0.106	474	2679	4.51	14.93
KpA7	26	0.101	507	2791	4.80	15.17
KpA8	30	0.092	480	2574	4.56	14.69
KpA9	46	0.070	491	2763	4.66	15.11
KpA10	57	0.099	492	2645	4.67	14.85
Total	296	0.098	490	2707	4.65	14.99
SD		0.05	33.25	160.07	0.29	0.35

M.2 KpA /e/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	6	0.095	533	2581	5.02	14.70
KpA2	13	0.155	567	2592	5.31	14.73
KpA3	10	0.115	549	2874	5.16	15.35
KpA4	21	0.123	556	2625	5.22	14.81
KpA5	19	0.134	556	2734	5.22	15.05
KpA6	8	0.149	533	2709	5.02	15.00
KpA7	14	0.087	540	2783	5.08	15.16
KpA8	19	0.108	531	2547	5.00	14.62
KpA9	55	0.102	547	2733	5.14	15.05
KpA10	16	0.117	543	2607	5.11	14.76
Total	181	0.115	547	2685	5.14	14.94
SD		0.05	23.97	166.20	0.20	0.39

M.3 KpA /ɛ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	50	0.104	643	2440	5.93	14.36
KpA2	30	0.145	677	2561	6.21	14.66
KpA3	33	0.129	672	2526	6.17	14.57

'Appendix M.3, continued'

KpA4	36	0.091	657	2480	6.05	14.46
KpA5	30	0.141	661	2630	6.08	14.82
KpA6	24	0.148	643	2501	5.93	14.51
KpA7	31	0.118	645	2604	5.95	14.76
KpA8	40	0.130	627	2329	5.81	14.07
KpA9	67	0.092	645	2476	5.95	14.45
KpA10	20	0.128	635	2470	5.87	14.44
Total	361	0.118	650	2493	5.99	14.49
SD		0.06	49.68	173.08	0.39	0.43

M.4 KpA /ɯ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	10	0.084	549	1838	5.16	12.55
KpA2	7	0.131	567	1934	5.31	12.89
KpA3	24	0.136	571	2019	5.35	13.17
KpA4	18	0.149	553	1950	5.19	12.94
KpA5	10	0.094	569	1802	5.33	12.42
KpA6	5	0.091	533	1926	5.02	12.86
KpA7	21	0.093	567	1940	5.31	12.91
KpA8	18	0.124	557	1892	5.23	12.74
KpA9	31	0.084	546	1891	5.13	12.74
KpA10	40	0.154	561	1863	5.26	12.64
Total	184	0.120	559	1908	5.24	12.80
SD		0.07	29.33	167.37	0.25	0.58

M.5 KpA /ə/*

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	Not found.					
KpA2	Not found.					
KpA3	Not found.					
KpA4	Not found.					
KpA5	2	0.106	553	1574	5.19	11.52
KpA6	Not found.					
KpA7	4	0.129	583	1383	5.44	10.65
KpA8	1	0.053	533	1614	5.02	11.69
KpA9	Not found.					
KpA10	Not found.					
Total	7	0.111	567	1471	5.31	11.07
SD		0.07	27.60	122.40	0.23	0.56

* all the words with /ə/ are realized as /ɵ/

M.6 KpA /ʌ/ - realized as /ɛ/ or /ɔ/

M.6.1 KpA /ʌ/ - realized as /ɛ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	27	0.113	637	2454	5.88	14.40
KpA2	17	0.145	667	2567	6.13	14.67
KpA3	17	0.127	669	2579	6.15	14.70
KpA4	15	0.101	645	2465	5.95	14.42
KpA5	12	0.143	670	2604	6.15	14.76
KpA6	12	0.147	646	2487	5.96	14.48
KpA7	14	0.115	650	2577	5.99	14.69
KpA8	18	0.158	622	2343	5.76	14.11
KpA9	24	0.090	636	2406	5.88	14.27
KpA10	7	0.148	631	2469	5.83	14.43
Total	163	0.125	646	2485	5.96	14.45
SD		0.07	47	172	0.38	0.43

M.6.2 KpA /ʌ/ - realized as /ɔ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	1	0.059	733	1494	6.64	11.17
KpA2	3	0.134	680	1293	6.23	10.20
KpA3	2	0.099	653	1393	6.02	10.70
KpA4	1	0.084	693	1534	6.33	11.35
KpA5	2	0.109	653	1314	6.02	10.31
KpA6	1	0.103	573	1333	5.36	10.41
KpA7	3	0.082	680	1440	6.23	10.93
KpA8	2	0.080	573	1213	5.36	9.77
KpA9	1	0.078	693	1373	6.33	10.60
KpA10	3	0.100	668	1310	6.13	10.29
Total	19	0.097	660	1353	6.06	10.48
SD		0.04	57.12	129.26	0.46	0.67

M.7 KpA /a/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	72	0.082	787	1815	7.05	12.47
KpA2	54	0.129	797	1773	7.12	12.31

'Appendix M.7, continued'

KpA3	56	0.113	962	1997	8.26	13.09
KpA4	53	0.106	848	1832	7.49	12.53
KpA5	65	0.111	879	1878	7.71	12.69
KpA6	44	0.104	801	1765	7.15	12.29
KpA7	65	0.091	845	1853	7.47	12.61
KpA8	38	0.106	809	1758	7.21	12.26
KpA9	299	0.085	900	1940	7.85	12.91
KpA10	81	0.105	810	1836	7.21	12.55
Total	827	0.097	860	1875	7.57	12.69
SD		0.04	92.66	189.20	0.64	0.67

M.8 KpA /ɑ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	20	0.087	765	1456	6.88	11.00
KpA2	26	0.136	764	1421	6.87	10.84
KpA3	2	0.166	873	1494	7.66	11.17
KpA4	4	0.076	773	1403	6.94	10.75
KpA5	1	0.098	813	1494	7.24	11.17
KpA6	6	0.119	740	1487	6.69	11.14
KpA7	5	0.122	805	1478	7.18	11.10
KpA8	8	0.098	778	1408	6.98	10.77
KpA9	8	0.085	773	1414	6.94	10.80
KpA10	10	0.132	766	1417	6.89	10.82
Total	90	0.112	770	1436	6.92	10.90
SD		0.043	54	61	0.40	0.29

M.9 KpA /u/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	2	0.164	493	1273	4.68	10.10
KpA2	2	0.075	493	1293	4.68	10.20
KpA3	7	0.134	516	1293	4.87	10.20
KpA4	1	0.083	533	1173	5.02	9.55
KpA5	4	0.101	493	1293	4.68	10.20
KpA6	2	0.073	533	1353	5.02	10.51
KpA7	6	0.151	513	1186	4.85	9.63
KpA8	9	0.091	497	1253	4.71	9.99
KpA9	32	0.089	499	1306	4.73	10.27
KpA10	6	0.070	500	1340	4.73	10.44
Total	71	0.099	503	1290	4.76	10.19
SD		0.05	22.89	109.16	0.20	0.57

M.10 KpA /o/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	13	0.094	527	1222	4.97	9.82
KpA2	45	0.159	561	1138	5.26	9.35
KpA3	18	0.128	555	1264	5.21	10.05
KpA4	19	0.128	558	1226	5.24	9.84
KpA5	17	0.105	535	1239	5.04	9.91
KpA6	3	0.139	546	1347	5.13	10.47
KpA7	17	0.123	554	1235	5.20	9.90
KpA8	26	0.090	525	1182	4.96	9.60
KpA9	29	0.087	552	1230	5.19	9.86
KpA10	19	0.076	546	1235	5.14	9.89
Total	206	0.115	548	1209	5.15	9.75
SD		0.068	26.56	117.65	0.23	0.66

M.11 KpA /ɔ/

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KpA1	29	0.112	630	1224	5.83	9.83
KpA2	28	0.125	663	1263	6.10	10.04
KpA3	14	0.100	653	1302	6.02	10.24
KpA4	16	0.132	643	1256	5.93	10.00
KpA5	29	0.106	670	1304	6.15	10.26
KpA6	8	0.099	628	1338	5.81	10.43
KpA7	22	0.090	660	1290	6.07	10.18
KpA8	22	0.098	624	1253	5.78	9.99
KpA9	29	0.090	647	1296	5.97	10.22
KpA10	13	0.090	650	1318	5.99	10.33
Total	210	0.105	648	1278	5.98	10.12
SD		0.05	47.73	120.96	0.38	0.63

APPENDIX N

Ach diphthongs measurements in average values from WE:

N.1.1 F1 ROC from Ach /iə/ from *tiep* [tiəp] 'every, each'

LC[2]	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.[3]	Ave. Dur.[4]	Ave. F1 ROC (Hz/sec)
Ach1	3	469	456	4.46	4.35	-13	0.082	-159
Ach2	3	482	521	4.58	4.92	39	0.076	518
Ach3	3	404	430	3.88	4.12	26	0.154	169
Ach4	3	464	595	4.42	5.55	131	0.094	1392
Ach5	3	430	521	4.12	4.92	91	0.152	596
Ach6	3	535	561	5.04	5.26	26	0.099	263
Ach7	3	508	522	4.81	4.92	14	0.076	181
Ach8	3	430	521	4.12	4.92	91	0.111	823
Ach9	3	378	469	3.65	4.46	91	0.178	511
Ach10	3	391	442	3.76	4.23	51	0.113	451
Total	30	449	504	4.29	4.77	55	0.113	483
SD		55.51	65.07	0.49	0.57	57.91	0.05	586.92

N.1.2 F2 ROC from Ach /iə/ from *tiep* [tiəp] 'every, each'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	2627	1986	14.81	13.06	-641	0.082	-7845
Ach2	3	2495	1821	14.50	12.49	-674	0.076	-8873
Ach3	3	2847	2001	15.29	13.11	-847	0.154	-5510
Ach4	3	2666	1763	14.90	12.28	-902	0.094	-9565
Ach5	3	2820	2691	15.24	14.96	-129	0.152	-849
Ach6	3	2757	2051	15.10	13.27	-706	0.099	-7131
Ach7	3	2548	1921	14.63	12.84	-627	0.076	-8291
Ach8	3	2620	1954	14.79	12.95	-666	0.111	-5997
Ach9	3	2613	1724	14.78	12.13	-889	0.178	-4994
Ach10	3	2901	1659	15.40	11.87	-1242	0.113	-10991
Total	30	2689	1957	14.95	12.96	-732	0.113	-6456
SD		136.30	303.50	0.30	0.92	300.11	0.05	3176.47

[2] LC refers to Language Consultant
[3] Dif. refers to the difference of the value from EndingF1-BeginningF1of the vowel
[4] Dur. refers to the duration of the vowel production

N.2.1 F1 ROC from Ach /ɯə/ from *beuet* [bɯət] 'study, learn

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	495	482	4.69	4.58	-13	0.083	-157
Ach2	3	482	600	4.58	5.58	118	0.089	1327
Ach3	3	456	600	4.35	5.58	144	0.127	1134
Ach4	3	449	574	4.29	5.37	125	0.111	1126
Ach5	3	547	613	5.14	5.69	66	0.146	451
Ach6	3	495	613	4.69	5.69	118	0.120	983
Ach7	3	521	508	4.92	4.80	-14	0.070	-196
Ach8	3	456	562	4.35	5.26	106	0.164	643
Ach9	3	339	430	3.29	4.12	91	0.192	473
Ach10	3	378	482	3.65	4.58	104	0.124	836
Total	30	462	546	4.40	5.13	84	0.123	689
SD		67.81	71.14	0.60	0.61	70.36	0.04	709.65

N.2.2 F2 ROC from Ach /ɯə/ from *beuet* [bɯət] 'study, learn

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1632	1842	11.77	12.57	210	0.083	2536
Ach2	3	1593	2035	11.60	13.22	442	0.089	4981
Ach3	3	1400	1961	10.74	12.98	561	0.127	4415
Ach4	3	1580	1881	11.55	12.71	301	0.111	2709
Ach5	3	1751	2085	12.23	13.37	334	0.146	2295
Ach6	3	1345	1907	10.47	12.79	562	0.120	4683
Ach7	3	1293	1816	10.20	12.47	523	0.070	7502
Ach8	3	1433	1816	10.89	12.47	383	0.164	2329
Ach9	3	1737	2038	12.18	13.23	301	0.192	1565
Ach10	3	1411	2077	10.79	13.35	666	0.124	5359
Total	30	1518	1946	11.28	12.93	428	0.123	3493
SD		162.23	115.05	0.71	0.39	156.37	0.04	2086.84

N.3.1 F1 ROC from Ach /uə/ from *buet* [buət] 'work, job, action'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	417	508	4.00	4.81	91	0.129	707
Ach2	3	416	560	3.99	5.25	144	0.102	1410
Ach3	3	522	665	4.92	6.11	144	0.167	859

‘Appendix N.3.1, continued’

Ach4	3	404	626	3.88	5.80	222	0.118	1879
Ach5	3	469	613	4.47	5.69	144	0.166	864
Ach6	3	456	574	4.35	5.37	118	0.107	1106
Ach7	3	495	495	4.70	4.70	0	0.075	0
Ach8	3	417	600	4.00	5.58	183	0.160	1146
Ach9	3	352	417	3.41	4.00	65	0.237	274
Ach10	3	378	495	3.65	4.70	117	0.131	898
Total	30	433	555	4.14	5.21	123	0.139	882
SD		65.84	83.99	0.58	0.71	79.66	0.05	717.16

N.3.2 F2 ROC from Ach /uə/ from *buet* [buət] ‘work, job, action’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1110	1595	9.19	11.61	485	0.1287	3767
Ach2	3	1056	1802	8.86	12.42	746	0.1023	7290
Ach3	3	1129	1808	9.30	12.45	679	0.1673	4060
Ach4	3	1018	1685	8.62	11.98	667	0.1183	5637
Ach5	3	1204	1805	9.72	12.43	601	0.1660	3620
Ach6	3	1058	1358	8.87	10.53	300	0.1067	2813
Ach7	3	1227	1319	9.85	10.33	92	0.0753	1217
Ach8	3	994	1724	8.47	12.13	730	0.1597	4572
Ach9	3	861	1528	7.58	11.33	667	0.2370	2816
Ach10	3	1031	1803	8.71	12.43	772	0.1307	5906
Total	30	1069	1643	8.94	11.81	574	0.139	4123
SD		112.83	186.47	0.70	0.80	222.6	0.05	1821.74

N.4.1 F1 ROC from Ach /ɛə/ from *kèe* [kɛə] ‘I, mine (informal/impolite form)’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	548	600	5.15	5.58	52	0.142	367
Ach2	3	657	670	6.04	6.15	13	0.198	67
Ach3	3	652	548	6.01	5.15	-104	0.217	-480
Ach4	3	665	692	6.11	6.32	26	0.181	145
Ach5	3	600	710	5.58	6.46	110	0.247	446
Ach6	3	639	718	5.90	6.52	79	0.220	357
Ach7	3	665	587	6.11	5.48	-78	0.178	-440
Ach8	3	652	710	6.01	6.46	58	0.253	229
Ach9	3	548	508	5.15	4.81	-40	0.201	-199
Ach10	3	626	783	5.80	7.02	157	0.241	651
Total	30	625	653	5.79	6.01	27	0.208	131
SD		53.15	87.91	0.43	0.71	93.48	0.05	457.05

N.4.2 F2 ROC from Ach /ɛə/ from *kèe* [kɛə] 'I, mine (informal/impolite form)'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	2391	2456	14.23	14.40	65	0.142	456
Ach2	3	2441	2211	14.36	13.75	-230	0.198	-1162
Ach3	3	2626	2629	14.81	14.81	3	0.217	12
Ach4	3	2352	2313	14.13	14.03	-39	0.181	-217
Ach5	3	2658	2448	14.88	14.38	-210	0.247	-851
Ach6	3	2613	2417	14.78	14.30	-196	0.220	-888
Ach7	3	2496	2469	14.50	14.43	-27	0.160	-167
Ach8	3	2374	2015	14.19	13.15	-359	0.253	-1419
Ach9	3	2430	2508	14.33	14.53	78	0.201	389
Ach10	3	2365	2012	14.17	13.14	-353	0.241	-1467
Total	30	2475	2348	14.45	14.12	-127	0.206	-616
SD		124.04	213.96	0.30	0.58	182.74	0.05	799.53

N.5.1 F1 ROC from Ach /ʌə/ from *dhöe* [dhʌə] 'clogged'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	652	535	6.01	5.04	-117	0.136	-863
Ach2	3	796	483	7.11	4.59	-313	0.224	-1401
Ach3	3	757	373	6.82	3.60	-384	0.253	-1520
Ach4	3	718	535	6.53	5.04	-183	0.169	-1083
Ach5	3	705	483	6.42	4.59	-222	0.168	-1319
Ach6	3	705	483	6.43	4.59	-222	0.203	-1093
Ach7	3	652	548	6.01	5.15	-104	0.162	-645
Ach8	3	665	587	6.11	5.48	-78	0.361	-216
Ach9	3	626	391	5.80	3.76	-235	0.151	-1560
Ach10	3	731	469	6.63	4.47	-262	0.232	-1129
Total	30	701	489	6.39	4.64	-212	0.207	-1026
SD		55.89	82.67	0.43	0.72	102.14	0.07	545.90

N.5.2 F2 ROC from Ach /ʌə/ from *dhöe* [dhʌə] 'clogged'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1767	1358	12.29	10.53	-409	0.145	-2825
Ach2	3	1790	1201	12.38	9.71	-588	0.230	-2562
Ach3	3	1962	1088	12.98	9.06	-874	0.253	-3458

‘Appendix N.5.2, continued’

Ach4	3	1672	1437	11.93	10.91	-235	0.169	-1390
Ach5	3	1737	1315	12.18	10.31	-422	0.168	-2509
Ach6	3	1803	1254	12.43	9.99	-549	0.203	-2700
Ach7	3	1476	1267	11.09	10.06	-209	0.162	-1293
Ach8	3	1646	1527	11.82	11.32	-119	0.361	-330
Ach9	3	1816	979	12.47	8.38	-837	0.151	-5553
Ach10	3	1776	1188	12.33	9.64	-588	0.232	-2538
Total	30	1744	1261	12.21	10.03	-483	0.207	-2330
SD		132.86	199.29	0.52	1.05	284.99	0.07	1748.64

N.6.1 F1 ROC from Ach /ɔe/ from *toe* [tɔe] ‘near’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	626	626	5.80	5.80	0	0.121	0
Ach2	3	679	417	6.22	4.00	-262	0.172	-1518
Ach3	3	731	507	6.63	4.80	-224	0.187	-1196
Ach4	3	652	430	6.01	4.12	-222	0.184	-1207
Ach5	3	665	639	6.11	5.90	-26	0.203	-128
Ach6	3	705	561	6.43	5.26	-144	0.159	-908
Ach7	3	679	705	6.22	6.43	26	0.116	227
Ach8	3	665	602	6.11	5.60	-63	0.281	-224
Ach9	3	548	495	5.15	4.70	-52	0.268	-195
Ach10	3	783	469	7.02	4.47	-314	0.163	-1920
Total	30	673	545	6.18	5.13	-128	0.185	-690
SD		64.76	99.52	0.51	0.84	124.72	0.06	815.90

N.6.2 F2 ROC from Ach /ɔe/ from *toe* [tɔe] ‘near’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1476	1240	11.09	9.92	-235	0.121	-1945
Ach2	3	1440	1175	10.93	9.56	-265	0.172	-1540
Ach3	3	1603	1332	11.65	10.40	-271	0.187	-1452
Ach4	3	1436	1449	10.91	10.97	13	0.187	70
Ach5	3	1502	1410	11.21	10.78	-91	0.203	-451
Ach6	3	1436	1293	10.91	10.20	-144	0.159	-905
Ach7	3	1463	1358	11.03	10.53	-105	0.116	-905
Ach8	3	1437	1097	10.91	9.11	-340	0.322	-1055
Ach9	3	1227	992	9.85	8.46	-235	0.268	-876
Ach10	3	1437	1280	10.91	10.13	-157	0.163	-961
Total	30	1446	1263	10.95	10.04	-183	0.190	-964
SD		110.07	176.71	0.51	0.96	174.86	0.07	1117.26

N.7.1 F1 ROC from Ach /ui/ from *bui* [bui] 'pig'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	417	482	4.00	4.58	65	0.133	485
Ach2	3	443	469	4.23	4.47	26	0.255	103
Ach3	3	417	417	4.00	4.00	0	0.267	0
Ach4	3	339	365	3.28	3.53	26	0.224	118
Ach5	3	443	521	4.23	4.92	78	0.254	309
Ach6	3	508	417	4.81	4.00	-91	0.267	-342
Ach7	3	521	495	4.92	4.70	-26	0.148	-176
Ach8	3	443	391	4.23	3.76	-52	0.234	-222
Ach9	3	326	326	3.16	3.16	0	0.405	0
Ach10	3	417	404	4.00	3.88	-13	0.235	-55
Total	30	427	429	4.09	4.11	1	0.242	6
SD		76.16	70.75	0.68	0.63	78.60	0.08	413.63

N.7.2 F2 ROC from Ach /ui/ from *bui* [bui] 'pig'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1084	2417	9.03	14.30	1333	0.133	10000
Ach2	3	1301	2644	10.24	14.85	1343	0.255	5274
Ach3	3	1062	2948	8.90	15.50	1886	0.267	7064
Ach4	3	1031	2665	8.71	14.90	1634	0.224	7295
Ach5	3	1177	2901	9.57	15.40	1724	0.254	6796
Ach6	3	1097	2718	9.11	15.02	1621	0.267	6070
Ach7	3	1045	2548	8.79	14.62	1503	0.148	10178
Ach8	3	1024	2705	0.00	14.99	2705	0.234	11543
Ach9	3	979	2744	0.00	15.07	2744	0.405	6770
Ach10	3	1097	2953	9.11	15.51	1856	0.185	10020
Total	30	1090	2724	9.07	15.03	1635	0.237	6891
SD		100.35	171.61	0.58	0.38	196.72	0.09	2442.66

N.8.1 F1 ROC from Ach /əi/ from *hei* [həi] 'to call'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	587	469	5.48	4.46	-118	0.112	-1054
Ach2	3	626	456	5.80	4.35	-170	0.210	-810
Ach3	3	665	430	6.11	4.12	-235	0.197	-1197
Ach4	3	639	456	5.90	4.35	-183	0.185	-991

‘Appendix N.8.1, continued’

Ach5	3	652	561	6.01	5.26	-91	0.229	-399
Ach6	3	626	495	5.80	4.70	-131	0.270	-484
Ach7	3	692	469	6.32	4.46	-223	0.134	-1658
Ach8	3	626	391	5.80	3.76	-235	0.213	-1102
Ach9	3	679	378	6.22	3.65	-301	0.210	-1434
Ach10	3	626	430	5.80	4.12	-196	0.216	-909
Total	30	642	454	5.92	4.33	-188	0.198	-953
SD		40.72	61.31	0.33	0.54	76.59	0.06	483.46

N.8.2 F2 ROC from Ach /əi/ from *hei* [həi] ‘to call’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1737	2274	12.18	13.92	537	0.112	4792
Ach2	3	1711	2640	12.08	14.84	929	0.210	4422
Ach3	3	1663	2334	11.89	14.08	671	0.197	3414
Ach4	3	1737	2652	12.18	14.87	915	0.185	4955
Ach5	3	1842	2649	12.57	14.86	807	0.229	3524
Ach6	3	1855	2744	12.61	15.07	889	0.270	3291
Ach7	3	1685	2469	11.98	14.43	784	0.134	5839
Ach8	3	1607	2739	11.66	15.06	1132	0.213	5306
Ach9	3	1855	2744	12.61	15.07	889	0.210	4240
Ach10	3	1724	2783	12.13	15.16	1059	0.216	4910
Total	30	1742	2603	12.20	14.75	861	0.198	4360
SD		94.80	193.34	0.36	0.47	188.30	0.06	1226.66

N.9.1 F1 ROC from Ach /oi/ from *bhôi* [bhoi] ‘sponge cake’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	522	482	4.92	4.58	-39	0.160	-245
Ach2	3	482	482	4.58	4.58	0	0.339	0
Ach3	3	548	469	5.15	4.46	-79	0.292	-271
Ach4	3	430	495	4.12	4.70	65	0.207	315
Ach5	3	494	587	4.69	5.48	93	0.293	317
Ach6	3	561	509	5.26	4.81	-52	0.282	-185
Ach7	3	417	495	4.00	4.70	78	0.154	509
Ach8	3	521	469	4.92	4.47	-52	0.259	-199
Ach9	3	430	391	4.12	3.77	-39	0.348	-111
Ach10	3	404	404	3.88	3.88	0	0.255	0
Total	30	481	478	4.57	4.55	-2	0.259	-10
SD		60.26	71.04	0.53	0.62	80.56	0.07	369.20

N.9.2 F2 ROC from Ach /oi/ from *bhôi* [bhoi] 'sponge cake'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1110	2352	9.18	14.13	1242	0.160	7748
Ach2	3	1175	2626	9.56	14.81	1451	0.339	4279
Ach3	3	1123	2374	9.26	14.19	1251	0.292	4284
Ach4	3	1044	2613	8.79	14.78	1569	0.207	7566
Ach5	3	1222	2909	9.82	15.42	1687	0.293	5765
Ach6	3	1254	2744	9.99	15.07	1490	0.282	5279
Ach7	3	1071	2600	8.95	14.75	1528	0.154	9924
Ach8	3	1069	2536	8.94	14.60	1467	0.259	5656
Ach9	3	979	2600	8.38	14.75	1621	0.348	4663
Ach10	3	1123	2861	9.26	15.32	1738	0.255	6826
Total	30	1117	2622	9.23	14.80	1504	0.259	5810
SD		94.57	203.11	0.55	0.49	193.12	0.07	2141.21

N.10.1 F1 ROC from Ach /ʌi/ from *lagöina* [lagʌina] 'very'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	665	456	6.11	4.35	-209	0.118	-1771
Ach2	3	667	548	6.12	5.15	-119	0.110	-1082
Ach3	3	744	416	6.72	3.99	-328	0.095	-3456
Ach4	3	718	548	6.53	5.15	-170	0.098	-1729
Ach5	3	705	535	6.43	5.04	-170	0.272	-626
Ach6	3	757	469	6.82	4.46	-288	0.123	-2348
Ach7	3	705	521	6.43	4.92	-184	0.103	-1777
Ach8	3	665	508	6.11	4.81	-157	0.120	-1308
Ach9	3	508	404	4.81	3.88	-104	0.121	-857
Ach10	3	665	417	6.11	4.00	-248	0.105	-2362
Total	30	680	482	6.23	4.58	-198	0.127	-1562
SD		67.34	62.18	0.55	0.55	75.48	0.05	862.37

N.10.2 F2 ROC from Ach /ʌi/ from *lagöina* [lagʌina] 'very'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1763	2509	12.28	14.53	746	0.118	6319
Ach2	3	1684	2333	11.97	14.08	649	0.110	5918
Ach3	3	1597	2614	11.62	14.78	1017	0.095	10702

‘Appendix N.10.2, continued’

Ach4	3	1934	2731	12.89	15.04	797	0.098	8108
Ach5	3	1476	2816	11.09	15.23	1340	0.272	4928
Ach6	3	1737	2692	12.18	14.96	954	0.123	7780
Ach7	3	1672	2613	11.93	14.78	941	0.103	9106
Ach8	3	1495	2536	11.18	14.60	1041	0.120	8678
Ach9	3	1175	2352	9.56	14.13	1177	0.121	9701
Ach10	3	1881	2548	12.71	14.63	667	0.105	6349
Total	30	1641	2574	11.80	14.69	933	0.127	7373
SD		230.03	151.23	0.97	0.36	233.44	0.05	2077.15

N.11.1 F1 ROC from Ach /ɔi/ from *poih* [pɔih̯] ‘mail, post’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	626	639	5.80	5.91	13	0.087	153
Ach2	3	691	534	6.32	5.03	-157	0.084	-1866
Ach3	3	757	516	6.82	4.88	-241	0.113	-2136
Ach4	3	665	679	6.11	6.22	14	0.099	139
Ach5	3	731	588	6.63	5.48	-143	0.170	-843
Ach6	3	705	600	6.43	5.58	-105	0.176	-595
Ach7	3	678	508	6.22	4.81	-170	0.088	-1943
Ach8	3	744	588	6.72	5.48	-156	0.094	-1654
Ach9	3	770	482	6.92	4.58	-288	0.098	-2949
Ach10	3	712	443	6.48	4.23	-269	0.119	-2260
Total	30	705	558	6.42	5.23	-147	0.113	-1302
SD		48.46	84.55	0.38	0.72	110.57	0.04	1237.77

N.11.2 F2 ROC from Ach /ɔi/ from *poih* [pɔih̯] ‘mail, post’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1136	1829	9.34	12.52	693	0.087	7935
Ach2	3	1278	1981	10.12	13.04	703	0.084	8336
Ach3	3	1267	1467	10.06	11.05	200	0.113	1768
Ach4	3	1188	1384	9.64	10.66	196	0.099	1986
Ach5	3	1278	1808	10.12	12.44	530	0.170	3122
Ach6	3	1214	1711	9.78	12.08	497	0.176	2819
Ach7	3	1214	1920	9.78	12.84	706	0.088	8053
Ach8	3	1177	1806	9.57	12.44	629	0.094	6671
Ach9	3	1097	1973	9.11	13.01	876	0.098	8969
Ach10	3	1188	2012	9.64	13.14	824	0.119	6922
Total	30	1204	1789	9.72	12.38	585	0.113	5188
SD		68.76	263.70	0.39	1.14	272.23	0.04	3330.01

N.12.1 F1 ROC from Ach /ai/ from *jai* [dʒai] ‘many, much’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	3	770	482	6.92	4.58	-288	0.186	-1546
Ach2	3	809	450	7.21	4.30	-359	0.273	-1316
Ach3	3	872	595	7.66	5.54	-277	0.177	-1568
Ach4	3	914	482	7.94	4.58	-432	0.171	-2524
Ach5	3	763	468	6.87	4.46	-295	0.261	-1129
Ach6	3	901	469	7.85	4.47	-431	0.264	-1636
Ach7	3	718	404	6.52	3.88	-314	0.166	-1886
Ach8	3	812	404	7.23	3.88	-408	0.324	-1260
Ach9	3	861	417	7.58	4.00	-444	0.267	-1666
Ach10	3	953	391	8.21	3.76	-562	0.230	-2443
Total	30	837	456	7.41	4.35	-381	0.232	-1643
SD		88.70	121.52	0.63	0.97	159.24	0.07	942.46

N.12.2 F2 ROC from Ach /ai/ from *jai* [dʒai] ‘many, much’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	3	1894	2469	12.75	14.43	575	0.186	3086
Ach2	3	1922	2602	12.85	14.75	680	0.273	2490
Ach3	3	2027	2614	13.19	14.78	587	0.177	3323
Ach4	3	1960	2613	12.97	14.78	654	0.171	3823
Ach5	3	2119	2848	13.48	15.29	728	0.261	2791
Ach6	3	1973	2835	13.02	15.27	862	0.264	3271
Ach7	3	2169	2626	13.62	14.81	457	0.166	2749
Ach8	3	1842	2691	12.57	14.96	849	0.324	2621
Ach9	3	1921	2626	12.84	14.81	705	0.267	2645
Ach10	3	2038	2862	13.23	15.32	824	0.230	3581
Total	30	1987	2679	13.06	14.93	692	0.232	2985
SD		119.31	180.77	0.38	0.43	210.83	0.07	939.58

APPENDIX O

KpA diphthongs measurements in average values from WE:

O.1.1 F1 ROC from KpA /iə/ from *tiep* [tiəp] 'every, each'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	430	404	4.12	3.88	-26	0.126	-206
KpA2	3	466	466	4.44	4.44	0	0.141	0
KpA3	3	453	453	4.32	4.32	0	0.136	0
KpA4	3	493	493	4.68	4.68	0	0.163	0
KpA5	3	480	453	4.56	4.32	-27	0.085	-314
KpA6	3	426	426	4.08	4.08	0	0.102	0
KpA7	3	480	480	4.56	4.56	0	0.110	0
KpA8	3	466	466	4.44	4.44	0	0.103	0
KpA9	3	426	453	4.08	4.32	27	0.119	224
KpA10	3	466	466	4.44	4.44	0	0.124	0
Total	30	459	456	4.37	4.35	-3	0.121	-21
SD		31.85	35.51	0.28	0.32	23.10	0.03	241.14

O.1.2 F2 ROC from KpA /iə/ from *tiep* [tiəp] 'every, each'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	2738	2574	15.06	14.69	-164	0.126	-1299
KpA2	3	2774	2827	15.14	15.25	53	0.141	377
KpA3	3	3162	3135	15.91	15.86	-27	0.136	-197
KpA4	3	2601	1907	14.75	12.80	-693	0.163	-4245
KpA5	3	2681	2027	14.93	13.19	-653	0.085	-7686
KpA6	3	2707	2734	14.99	15.05	27	0.102	261
KpA7	3	3095	3015	15.78	15.63	-80	0.091	-876
KpA8	3	2641	2614	14.84	14.78	-27	0.103	-259
KpA9	3	2908	2908	15.42	15.42	0	0.119	0
KpA10	3	2694	2721	14.96	15.02	27	0.124	214
Total	30	2800	2646	15.19	14.86	-154	0.119	-1290
SD		194.89	406.47	0.40	1.03	298.07	0.03	2698.07

O.2.1 F1 ROC from KpA /ɯə/ from *beuet* [bɯət] 'study, learn'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	456	417	4.35	4.00	-39	0.175	-223
KpA2	3	493	493	4.68	4.68	0	0.171	0
KpA3	3	506	493	4.79	4.68	-13	0.136	-98
KpA4	3	546	480	5.13	4.56	-67	0.169	-395
KpA5	3	520	466	4.91	4.44	-53	0.131	-408
KpA6	3	466	426	4.44	4.08	-40	0.101	-396
KpA7	3	506	493	4.79	4.68	-13	0.177	-75
KpA8	3	493	466	4.68	4.44	-27	0.135	-198
KpA9	3	466	413	4.44	3.96	-53	0.168	-317
KpA10	3	506	480	4.79	4.56	-27	0.128	-209
Total	30	496	463	4.70	4.41	-33	0.149	-223
SD		31.54	37.35	0.27	0.33	33.26	0.03	225.03

O.2.2 F2 ROC from KpA /ɯə/ from *beuet* [bɯət] 'study, learn'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1814	2401	12.47	14.26	587	0.175	3352
KpA2	3	1641	1947	11.80	12.93	307	0.171	1797
KpA3	3	1707	1974	12.07	13.02	266	0.128	2081
KpA4	3	1841	2027	12.56	13.19	187	0.169	1107
KpA5	3	1961	2214	12.98	13.75	253	0.131	1939
KpA6	3	1827	2254	12.52	13.87	427	0.101	4224
KpA7	3	1801	2067	12.42	13.32	267	0.177	1507
KpA8	3	1493	2027	11.17	13.19	534	0.135	3965
KpA9	3	1654	1921	11.85	12.84	267	0.168	1587
KpA10	3	1627	2027	11.75	13.19	400	0.128	3133
Total	30	1737	2086	12.18	13.37	349	0.148	2358
SD		150.53	157.03	0.59	0.47	157.70	0.04	1421.07

O.3.1 F1 ROC from KpA /uə/ from *buet* [buət] 'work, job, action'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	378	430	3.65	4.12	52	0.163	319
KpA2	3	453	440	4.32	4.20	-13	0.145	-92
KpA3	3	480	493	4.56	4.68	13	0.116	115

‘Appendix O.3.1, continued’

KpA4	3	493	480	4.68	4.56	-14	0.185	-74
KpA5	3	480	493	4.56	4.68	13	0.153	87
KpA6	3	413	440	3.96	4.20	27	0.109	245
KpA7	3	426	466	4.08	4.44	40	0.124	323
KpA8	3	466	493	4.44	4.68	27	0.117	228
KpA9	3	440	453	4.20	4.32	13	0.172	78
KpA10	3	466	466	4.44	4.44	0	0.114	0
Total	30	450	465	4.29	4.43	16	0.140	113
SD		37.88	30.74	0.34	0.27	26.84	0.03	193.19

O.3.2 F2 ROC from KpA /uə/ from *buet* [buət] ‘work, job, action’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	940	1293	8.12	10.20	353	0.163	2166
KpA2	3	880	1280	7.71	10.13	400	0.145	2765
KpA3	3	1040	2054	8.76	13.28	1014	0.116	8744
KpA4	3	1026	2054	8.68	13.28	1028	0.185	5565
KpA5	3	1080	1280	9.01	10.13	200	0.153	1310
KpA6	3	1186	2107	9.63	13.44	921	0.109	8450
KpA7	3	1053	1961	8.84	12.98	908	0.124	7340
KpA8	3	946	2041	8.16	13.23	1094	0.117	9353
KpA9	3	1000	1293	8.51	10.20	293	0.172	1709
KpA10	3	946	1213	8.16	9.77	267	0.114	2339
Total	30	1010	1658	8.57	11.87	648	0.140	4639
SD		92.38	398.88	0.58	1.62	362.74	0.03	3230.29

O.4.1 F1 ROC from KpA /ɛə/ from *kèe* [kɛə] ‘I, mine (informal/impolite form)’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	548	574	5.15	5.37	26	0.246	107
KpA2	3	586	613	5.47	5.69	27	0.246	109
KpA3	3	626	586	5.80	5.47	-40	0.182	-220
KpA4	3	626	626	5.80	5.80	0	0.179	0
KpA5	3	546	613	5.13	5.69	67	0.209	319
KpA6	3	546	573	5.13	5.36	27	0.187	143
KpA7	3	546	546	5.13	5.13	0	0.208	0
KpA8	3	560	573	5.25	5.36	13	0.189	71
KpA9	3	586	560	5.47	5.25	-27	0.228	-117
KpA10	3	640	600	5.91	5.58	-40	0.226	-177
Total	30	581	586	5.43	5.47	5	0.210	25
SD		44.51	42.83	0.37	0.36	47.78	0.05	233.80

O.4.2 F2 ROC from KpA /ɛə/ from *kèe* [kɛə] 'I, mine (informal/impolite form)'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	2600	2600	14.75	14.75	0	0.246	0
KpA2	3	2641	2614	14.84	14.78	-27	0.246	-109
KpA3	3	2868	2868	15.34	15.34	0	0.182	0
KpA4	3	2547	2547	14.62	14.62	0	0.179	0
KpA5	3	2707	2707	14.99	14.99	0	0.209	0
KpA6	3	2561	2561	14.66	14.66	0	0.187	0
KpA7	3	2881	2867	15.36	15.34	-13	0.208	-64
KpA8	3	2387	2387	14.23	14.23	0	0.189	0
KpA9	3	2734	2734	15.05	15.05	0	0.228	0
KpA10	3	2494	2494	14.49	14.49	0	0.226	0
Total	30	2642	2638	14.85	14.84	-4	0.210	-19
SD		160.16	158.23	0.37	0.37	12.21	0.05	58.05

O.5.1 F1 ROC from KpA /ʌə/ from *dhöe* [dhʌə] 'clogged up'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	665	508	6.11	4.81	-157	0.197	-797
KpA2	3	626	520	5.80	4.91	-106	0.232	-456
KpA3	3	639	508	5.90	4.81	-131	0.167	-783
KpA4	3	661	508	6.08	4.81	-153	0.200	-766
KpA5	3	639	521	5.90	4.92	-118	0.176	-670
KpA6	3	652	652	6.01	6.01	0	0.169	2
KpA7	3	648	548	5.98	5.15	-100	0.216	-463
KpA8	3	626	503	5.80	4.76	-123	0.158	-777
KpA9	3	626	508	5.80	4.81	-118	0.205	-577
KpA10	3	652	532	6.01	5.01	-120	0.162	-739
Total	30	643	531	5.94	5.00	-113	0.188	-598
SD		19.14	46.04	0.15	0.38	48.95	0.04	285.45

O.5.2 F2 ROC from KpA /ʌə/ from *dhöe* [dhʌə] 'clogged up'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1384	1254	10.66	10.00	-130	0.197	-660
KpA2	3	1332	1227	10.40	9.85	-105	0.232	-453
KpA3	3	1358	1148	10.53	9.41	-211	0.167	-1259

‘Appendix O.5.2, continued’

KpA4	3	1346	1110	10.47	9.19	-236	0.200	-1182
KpA5	3	1397	1160	10.72	9.48	-237	0.176	-1351
KpA6	3	1398	1227	10.72	9.85	-171	0.169	-1008
KpA7	3	1372	1136	10.60	9.34	-236	0.216	-1091
KpA8	3	1345	1120	10.47	9.24	-225	0.158	-1423
KpA9	3	1332	1136	10.40	9.34	-196	0.205	-958
KpA10	3	1384	1161	10.66	9.48	-223	0.162	-1376
Total	30	1365	1168	10.56	9.52	-197	0.188	-1047
SD		30.85	60.40	0.15	0.34	63.66	0.04	487.12

O.6.1 F1 ROC from KpA /ɔə/ from *toe* [tɔe] ‘near’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	665	443	6.11	4.23	-222	0.246	-901
KpA2	3	661	521	6.08	4.92	-140	0.238	-587
KpA3	3	626	508	5.80	4.81	-118	0.219	-540
KpA4	3	652	495	6.01	4.69	-157	0.190	-828
KpA5	3	613	569	5.69	5.33	-44	0.179	-245
KpA6	3	661	546	6.08	5.13	-115	0.164	-701
KpA7	3	622	530	5.76	4.99	-92	0.210	-438
KpA8	3	600	560	5.58	5.25	-40	0.158	-253
KpA9	3	640	469	5.91	4.46	-171	0.217	-788
KpA10	3	687	508	6.29	4.81	-179	0.183	-976
Total	30	643	515	5.93	4.87	-128	0.200	-637
SD		36.22	43.52	0.29	0.38	62.41	0.05	388.84

O.6.2 F2 ROC from KpA /ɔə/ from *toe* [tɔe] ‘near’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1450	1188	10.97	9.64	-262	0.244	-1074
KpA2	3	1320	1253	10.34	9.99	-67	0.238	-280
KpA3	3	1280	1173	10.13	9.55	-107	0.219	-488
KpA4	3	1253	1146	9.99	9.40	-107	0.190	-562
KpA5	3	1541	1186	11.38	9.63	-355	0.179	-1978
KpA6	3	1489	1333	11.15	10.41	-156	0.164	-951
KpA7	3	1266	1053	10.06	8.84	-213	0.210	-1016
KpA8	3	1253	1160	9.99	9.48	-93	0.158	-589
KpA9	3	1306	1173	10.27	9.55	-133	0.217	-615
KpA10	3	1384	1106	10.66	9.16	-278	0.183	-1516
Total	30	1354	1177	10.51	9.57	-177	0.200	-884
SD		112.93	87.46	0.55	0.49	113.66	0.05	871.30

O.7.1 F1 ROC from KpA /ui/ from *bui* [bui] 'pig'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	417	443	4.00	4.23	26	0.273	95
KpA2	3	373	386	3.60	3.72	13	0.264	51
KpA3	3	466	453	4.44	4.32	-13	0.215	-62
KpA4	3	480	426	4.56	4.08	-53	0.220	-243
KpA5	3	466	413	4.44	3.96	-53	0.204	-262
KpA6	3	453	386	4.32	3.72	-67	0.220	-303
KpA7	3	426	413	4.08	3.96	-13	0.251	-53
KpA8	3	453	440	4.32	4.20	-13	0.195	-68
KpA9	3	413	413	3.96	3.96	0	0.239	0
KpA10	3	440	426	4.20	4.08	-13	0.213	-63
Total	30	439	420	4.20	4.03	-19	0.229	-82
SD		37.32	28.19	0.33	0.25	37.30	0.04	162.12

O.7.2 F2 ROC from KpA /ui/ from *bui* [bui] 'pig'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1084	2705	9.03	14.99	1621	0.273	5932
KpA2	3	973	2801	8.34	15.20	1828	0.264	6923
KpA3	3	1226	3002	9.85	15.61	1775	0.215	8257
KpA4	3	1106	2721	9.16	15.02	1614	0.220	7349
KpA5	3	1080	2881	9.01	15.36	1801	0.204	8843
KpA6	3	1320	2747	10.34	15.08	1428	0.220	6480
KpA7	3	1080	2921	9.01	15.45	1842	0.251	7328
KpA8	3	1040	2641	8.76	14.84	1601	0.195	8196
KpA9	3	1133	2667	9.32	14.90	1535	0.239	6421
KpA10	3	1133	2641	9.32	14.84	1508	0.213	7078
Total	30	1117	2773	9.23	15.14	1655	0.229	7213
SD		103.00	127.39	0.60	0.27	153.00	0.04	1605.97

O.8.1 F1 ROC from KpA /əi/ from *hei* [həi] 'to call'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	521	495	4.92	4.69	-26	0.254	-104
KpA2	3	535	495	5.04	4.69	-40	0.277	-143
KpA3*	3	861	533	7.58	5.02	-328	0.268	-1224

‘Appendix O.8.1, continued’

KpA4	3	525	453	4.95	4.32	-72	0.168	-427
KpA5	3	516	453	4.88	4.32	-63	0.217	-292
KpA6	3	569	480	5.33	4.56	-89	0.228	-391
KpA7	3	533	440	5.02	4.20	-93	0.222	-420
KpA8	3	525	426	4.95	4.08	-98	0.208	-474
KpA9	3	508	453	4.81	4.32	-55	0.214	-257
KpA10	3	485	453	4.61	4.32	-32	0.192	-167
Total	30	524	461	4.94	4.39	-63	0.220	-288
SD		26.24	29.19	0.22	0.26	34.68	0.05	178.90

* /əi/ from *hei* is realized as /ai/ and excluded from data

O.8.2 F2 ROC from KpA /əi/ from *hei* [həi] ‘to call’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1200	2569	9.70	14.68	1369	0.254	5398
KpA2	3	1135	2654	9.33	14.87	1519	0.277	5484
KpA3*	3	1958	2921	12.97	15.45	963	0.268	3590
KpA4	3	1201	2814	9.71	15.22	1613	0.168	9601
KpA5	3	1175	2908	9.56	15.42	1733	0.205	8438
KpA6	3	1345	2774	10.47	15.14	1429	0.228	6258
KpA7	3	1200	2761	9.70	15.11	1561	0.222	7021
KpA8	3	1173	2654	9.55	14.87	1481	0.208	7130
KpA9	3	1186	2721	9.63	15.02	1534	0.214	7181
KpA10	3	1107	2614	9.17	14.78	1507	0.192	7861
Total	30	1191	2719	9.65	15.02	1527	0.219	6986
SD		68.63	113.75	0.37	0.25	112.08	0.05	2438.69

* /əi/ from *hei* is realized as /ai/ and excluded from data

O.9.1 F1 ROC from KpA /oi/ from *bhôi* [bhoi] ‘sponge cake’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	456	456	4.35	4.35	0	0.296	0
KpA2	3	546	506	5.13	4.79	-40	0.279	-144
KpA3	3	466	413	4.44	3.96	-53	0.241	-221
KpA4	3	506	453	4.79	4.32	-53	0.231	-231
KpA5	3	453	413	4.32	3.96	-40	0.207	-193
KpA6	3	493	413	4.68	3.96	-80	0.194	-413
KpA7	3	506	440	4.79	4.20	-67	0.279	-239

‘Appendix O.9.1, continued’

KpA8	3	466	413	4.44	3.96	-53	0.232	-230
KpA9	3	453	400	4.32	3.84	-53	0.257	-208
KpA10	3	480	413	4.56	3.96	-67	0.199	-334
Total	30	483	432	4.58	4.14	-51	0.241	-210
SD		36.53	38.13	0.32	0.34	33.11	0.05	161.16

O.9.2 F2 ROC from KpA /oi/ from *bhôi* [bhoi] ‘sponge cake’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1149	2653	9.41	14.87	1504	0.296	5086
KpA2	3	1013	2747	8.59	15.08	1734	0.279	6224
KpA3	3	1173	3068	9.55	15.73	1895	0.241	7864
KpA4	3	1093	2627	9.09	14.81	1534	0.231	6642
KpA5	3	1213	2867	9.77	15.34	1654	0.207	7992
KpA6	3	1226	2654	9.85	14.87	1428	0.194	7372
KpA7	3	1013	2867	8.59	15.34	1854	0.279	6638
KpA8	3	1186	2681	9.63	14.93	1494	0.232	6441
KpA9	3	1093	2707	9.09	14.99	1614	0.257	6290
KpA10	3	1146	2574	9.40	14.69	1428	0.199	7162
Total	30	1131	2745	9.31	15.07	1614	0.241	6685
SD		75.02	150.07	0.44	0.32	167.96	0.05	1382.34

O.10.1 F1 ROC from KpA /ʌi/ from *lagöina* [lagʌina] ‘very’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	644	508	5.94	4.81	-136	0.134	-1017
KpA2	3	546	533	5.13	5.02	-13	0.104	-129
KpA3	3	653	480	6.02	4.56	-173	0.166	-1042
KpA4	3	600	506	5.58	4.79	-93	0.120	-780
KpA5	3	626	533	5.80	5.02	-93	0.139	-673
KpA6	3	626	493	5.80	4.68	-133	0.125	-1067
KpA7	3	613	493	5.69	4.68	-120	0.129	-930
KpA8	3	573	493	5.36	4.68	-80	0.138	-580
KpA9	3	506	453	4.79	4.32	-53	0.114	-468
KpA10	3	533	453	5.02	4.32	-80	0.093	-863
Total	30	592	495	5.52	4.69	-98	0.126	-774
SD		50.33	28.17	0.42	0.25	46.61	0.03	337.52

O.10.2 F2 ROC from KpA /ʌi/ from *lagöina* [lagʌina] 'very'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1397	2507	10.72	14.53	1110	0.134	8307
KpA2	3	1080	1987	9.01	13.06	908	0.104	8756
KpA3	3	1533	2894	11.35	15.39	1361	0.166	8180
KpA4	3	1400	1921	10.74	12.84	520	0.120	4348
KpA5	3	1521	2654	11.29	14.87	1133	0.139	8173
KpA6	3	1774	2347	12.32	14.12	573	0.125	4587
KpA7	3	1521	2614	11.29	14.78	1093	0.129	8475
KpA8	3	1507	2414	11.23	14.29	907	0.138	6572
KpA9	3	1814	2027	12.47	13.19	213	0.114	1871
KpA10	3	1347	1987	10.47	13.06	641	0.093	6914
Total	30	1489	2335	11.15	14.09	846	0.126	6711
SD		226.61	330.93	1.05	0.89	352.06	0.03	2570.24

O.11.1 F1 ROC from KpA /ɔi/ from *poih* [pɔih̰] 'mail, post'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	508	456	4.81	4.35	-52	0.151	-345
KpA2	3	516	600	4.88	5.58	83	0.146	572
KpA3	3	525	480	4.95	4.56	-45	0.134	-336
KpA4	3	516	493	4.88	4.68	-23	0.102	-230
KpA5	3	546	493	5.13	4.68	-53	0.098	-542
KpA6	3	543	466	5.11	4.44	-77	0.114	-673
KpA7	3	533	453	5.02	4.32	-80	0.133	-600
KpA8	3	516	466	4.88	4.44	-50	0.123	-408
KpA9	3	535	466	5.04	4.44	-68	0.089	-771
KpA10	3	521	453	4.92	4.32	-68	0.087	-785
Total	30	526	483	4.96	4.58	-43	0.118	-369
SD		17.68	53.76	0.15	0.47	56.83	0.03	594.85

O.11.2 F2 ROC from KpA /ɔi/ from *poih* [pɔih̰] 'mail, post'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	1120	2443	9.24	14.37	1323	0.151	8783
KpA2	3	1026	1654	8.68	11.85	628	0.146	4309
KpA3	3	1200	2227	9.70	13.79	1028	0.134	7669

‘Appendix O.11.2, continued’

KpA4	3	1106	2041	9.16	13.23	934	0.102	9190
KpA5	3	1173	2454	9.55	14.40	1281	0.098	13027
KpA6	3	1136	2187	9.34	13.68	1051	0.114	9222
KpA7	3	1053	2174	8.84	13.64	1121	0.133	8408
KpA8	3	1133	2227	9.32	13.79	1094	0.123	8921
KpA9	3	1120	1360	9.24	10.54	240	0.089	2711
KpA10	3	1133	2027	9.32	13.19	894	0.087	10280
Total	30	1120	2080	9.25	13.35	960	0.118	8159
SD		56.96	342.73	0.34	1.27	327.42	0.03	3348.05

O.12.1 F1 ROC from KpA /ai/ from *jai* [dʒai] ‘many, much’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	3	866	453	7.62	4.32	-413	0.300	-1376
KpA2	3	866	546	7.62	5.13	-320	0.259	-1234
KpA3	3	1040	533	8.76	5.02	-507	0.238	-2132
KpA4	3	813	493	7.24	4.68	-320	0.218	-1466
KpA5	3	933	533	8.07	5.02	-400	0.196	-2037
KpA6	3	746	493	6.74	4.68	-253	0.209	-1214
KpA7	3	986	533	8.42	5.02	-453	0.267	-1700
KpA8	3	800	493	7.14	4.68	-307	0.171	-1790
KpA9	3	986	493	8.42	4.68	-493	0.293	-1682
KpA10	3	760	480	6.84	4.56	-280	0.179	-1564
Total	30	880	505	7.71	4.78	-375	0.233	-1607
SD		115.23	35.08	0.78	0.31	110.91	0.06	478.45

O.12.2 F2 ROC from KpA /ai/ from *jai* [dʒai] ‘many, much’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	3	2014	2681	13.15	14.93	667	0.300	2220
KpA2	3	2134	2641	13.52	14.84	507	0.259	1954
KpA3	3	2094	2988	13.40	15.58	894	0.238	3762
KpA4	3	1934	2734	12.89	15.05	800	0.218	3664
KpA5	3	2187	2707	13.68	14.99	520	0.196	2649
KpA6	3	2134	2641	13.52	14.84	507	0.209	2428
KpA7	3	2054	2841	13.28	15.28	787	0.267	2950
KpA8	3	2041	2641	13.23	14.84	600	0.171	3502
KpA9	3	2094	2694	13.40	14.96	600	0.293	2045
KpA10	3	2161	2454	13.60	14.40	293	0.179	1639
Total	30	2085	2702	13.37	14.98	617	0.233	2649
SD		81.15	147.39	0.25	0.32	186.48	0.06	885.95

APPENDIX P

Ach diphthongs measurements in average values from INT:

P.1.1 F1 ROC from Ach /iə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	5	429	501	4.11	4.75	72	0.077	930
Ach2	10	485	525	4.61	4.95	40	0.085	471
Ach3	13	499	591	4.73	5.51	92	0.080	1156
Ach4	11	490	599	4.65	5.58	110	0.070	1575
Ach5	1	493	613	4.68	5.69	120	0.093	1290
Ach6	8	453	516	4.32	4.87	63	0.097	648
Ach7	7	516	550	4.87	5.17	34	0.063	543
Ach8	4	493	563	4.68	5.28	70	0.054	1290
Ach9	6	446	453	4.26	4.32	7	0.095	71
Ach10	9	480	533	4.56	5.02	53	0.066	804
Total	74	481	546	4.57	5.13	65	0.077	846
SD		44.57	72.60	0.39	0.61	71.43	0.04	1040.74

P.1.2 F2 ROC from Ach /iə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	5	2422	2150	14.31	13.57	-272	0.077	-3514
Ach2	10	2514	2118	14.54	13.47	-396	0.085	-4665
Ach3	13	2562	2291	14.66	13.97	-271	0.080	-3392
Ach4	11	2822	2279	15.24	13.94	-543	0.070	-7808
Ach5	1	2975	2214	15.55	13.75	-761	0.093	-8183
Ach6	8	2597	2465	14.74	14.42	-131	0.097	-1355
Ach7	7	2580	2420	14.70	14.31	-160	0.063	-2534
Ach8	4	2484	1954	14.47	12.95	-530	0.054	-9770
Ach9	6	2507	2141	14.53	13.54	-367	0.095	-3880
Ach10	9	2663	2093	14.89	13.40	-570	0.066	-8593
Total	74	2599	2229	14.75	13.80	-371	0.077	-4804
SD		281.03	393.03	0.68	1.61	450.79	0.04	7003.64

P.2.1 F1 ROC from Ach /ɯə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	15	504	506	4.77	4.79	3	0.084	32
Ach2	14	550	564	5.17	5.29	14	0.087	164
Ach3	12	553	556	5.19	5.22	3	0.063	53
Ach4	9	542	635	5.10	5.87	93	0.060	1558
Ach5	24	558	555	5.23	5.21	-3	0.074	-45
Ach6	7	550	522	5.17	4.92	-29	0.072	-395
Ach7	18	469	493	4.46	4.68	24	0.077	320
Ach8	5	501	509	4.75	4.81	8	0.076	105
Ach9	28	464	453	4.42	4.32	-11	0.067	-170
Ach10	25	519	544	4.90	5.12	26	0.066	387
Total	157	515	526	4.87	4.96	10	0.072	144
SD		55.53	72.25	0.48	0.61	64.07	0.03	1033.20

P.2.2 F2 ROC from Ach /ɯə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	15	1937	1891	12.90	12.74	-45	0.084	-541
Ach2	14	2140	1911	13.54	12.81	-229	0.087	-2621
Ach3	12	2397	2237	14.25	13.82	-160	0.063	-2526
Ach4	9	2001	1796	13.11	12.40	-205	0.060	-3416
Ach5	24	2099	2032	13.41	13.21	-67	0.074	-898
Ach6	7	2083	2003	13.36	13.11	-80	0.072	-1107
Ach7	18	1956	1727	12.96	12.14	-229	0.077	-2995
Ach8	5	1549	1630	11.42	11.76	80	0.076	1058
Ach9	28	1873	1694	12.68	12.01	-179	0.067	-2663
Ach10	25	2030	1900	13.20	12.77	-130	0.066	-1959
Total	157	2018	1880	13.16	12.70	-139	0.072	-1917
SD		267.11	297.36	0.85	1.12	265.05	0.03	4686.74

P.3.1 F1 ROC from Ach /uə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	10	477	533	4.54	5.02	56	0.097	577
Ach2	15	501	549	4.75	5.16	48	0.090	536
Ach3	26	482	562	4.58	5.27	80	0.102	781

‘Appendix P.3.1, continued’

Ach4	12	480	590	4.56	5.50	110	0.132	832
Ach5	4	503	533	4.76	5.02	30	0.094	321
Ach6	3	443	520	4.23	4.91	77	0.110	695
Ach7	10	477	505	4.54	4.78	28	0.078	359
Ach8	3	506	506	4.79	4.79	0	0.060	0
Ach9	10	425	433	4.07	4.14	8	0.086	93
Ach10	31	494	576	4.69	5.38	81	0.073	1111
Total	124	482	546	4.58	5.13	64	0.092	696
SD		45.10	67.00	0.40	0.57	68.97	0.06	1031.78

P.3.2 F2 ROC from Ach /uə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	10	1181	1281	9.60	10.14	100	0.097	1032
Ach2	15	1307	1523	10.27	11.30	216	0.090	2411
Ach3	26	1173	1443	9.55	10.94	270	0.102	2639
Ach4	12	1173	1360	9.55	10.54	187	0.132	1415
Ach5	4	1193	1504	9.66	11.22	311	0.094	3321
Ach6	3	1226	1160	9.85	9.48	-67	0.110	-604
Ach7	10	1245	1333	9.95	10.41	88	0.078	1134
Ach8	3	1333	1494	10.41	11.17	161	0.060	2678
Ach9	10	1262	1158	10.04	9.46	-104	0.086	-1214
Ach10	31	1142	1432	9.37	10.89	289	0.073	3955
Total	124	1201	1393	9.71	10.70	192	0.092	2100
SD		152.05	288.97	0.84	1.33	304.35	0.06	4201.13

P.4.1 F1 ROC from Ach /ɛə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	20	627	591	5.81	5.51	-36	0.126	-285
Ach2	19	645	596	5.95	5.55	-48	0.105	-459
Ach3	9	631	600	5.84	5.58	-31	0.115	-269
Ach4	25	660	682	6.07	6.24	22	0.100	223
Ach5	16	621	623	5.75	5.77	3	0.116	22
Ach6	11	635	653	5.87	6.02	18	0.092	198
Ach7	24	665	680	6.11	6.23	15	0.070	216
Ach8	46	640	592	5.91	5.52	-48	0.082	-583
Ach9	11	609	566	5.66	5.30	-44	0.061	-717
Ach10	18	657	604	6.05	5.62	-53	0.099	-536
Total	199	642	620	5.93	5.75	-22	0.095	-234
SD		42.73	88.66	0.34	0.71	83.54	0.06	1180.61

P.4.2 F2 ROC from Ach /ɛə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	20	2350	2038	14.13	13.23	-312	0.126	-2473
Ach2	19	2374	2033	14.19	13.21	-341	0.105	-3236
Ach3	9	2592	2294	14.73	13.98	-298	0.115	-2579
Ach4	25	2353	2043	14.13	13.24	-309	0.100	-3082
Ach5	16	2509	2282	14.53	13.94	-227	0.116	-1961
Ach6	11	2527	2127	14.57	13.50	-400	0.092	-4352
Ach7	24	2381	1996	14.21	13.09	-385	0.070	-5533
Ach8	46	2383	2199	14.21	13.71	-183	0.082	-2236
Ach9	11	2323	2105	14.06	13.43	-218	0.061	-3587
Ach10	18	2332	2218	14.08	13.77	-113	0.099	-1140
Total	199	2394	2126	14.24	13.50	-268	0.095	-2828
SD		150.38	283.49	0.38	0.87	277.16	0.06	4030.92

P.5.1 F1 ROC from Ach /ʌə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	1	733	733	6.64	6.64	0	0.219	0
Ach3	3	639.667	573	5.91	5.36	-66.67	0.122	-548
Ach4	0	Not found.						
Ach5	0	Not found.						
Ach6	0	Not found.						
Ach7	0	Not found.						
Ach8	0	Not found.						
Ach9	0	Not found.						
Ach10	0	Not found.						
Total	4	663	613	6.10	5.69	-50	0.146	-342
SD		50.33	181.84	0.40	1.52	151.00	0.05	1179.04

P.5.2 F2 ROC from Ach /ʌə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	1	1814	1534	12.47	11.35	-280	0.219	-1279
Ach3	3	1854	1560.67	12.61	11.47	-293.3	0.122	-2411

‘Appendix P.5.2, continued’

Ach4	0	Not found.						
Ach5	0	Not found.						
Ach6	0	Not found.						
Ach7	0	Not found.						
Ach8	0	Not found.						
Ach9	0	Not found.						
Ach10	0	Not found.						
Total	4	1844	1554	12.57	11.85	-290	0.146	-1986
SD		143.76	69.28	0.49	0.10	75.72	0.05	723.11

P.6.1 F1 ROC from Ach /ɔə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	11	628	591	5.81	5.51	-36	0.100	-363
Ach2	6	666	613	6.12	5.69	-53	0.105	-507
Ach3	5	629	597	5.82	5.56	-32	0.196	-163
Ach4	13	647	656	5.97	6.04	9	0.087	106
Ach5	8	643	638	5.93	5.89	-5	0.117	-43
Ach6	1	613	493	5.69	4.68	-120	0.246	-488
Ach7	9	706	644	6.44	5.94	-62	0.075	-832
Ach8	2	613	553	5.69	5.19	-60	0.059	-1017
Ach9	1	613	613	5.69	5.69	0	0.099	0
Ach10	5	653	573	6.02	5.36	-80	0.048	-1681
Total	61	650	618	5.99	5.73	-33	0.101	-325
SD		50.00	82.98	0.40	0.68	84.38	0.06	1279.74

P.6.2 F2 ROC from Ach /ɔə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	11	1461	1406	11.02	10.76	-55	0.100	-545
Ach2	6	1313	1414	10.31	10.80	100	0.105	952
Ach3	5	1413	1357	10.80	10.53	-56	0.196	-284
Ach4	13	1309	1377	10.28	10.62	68	0.087	784
Ach5	8	1419	1318	10.82	10.33	-101	0.117	-856
Ach6	1	1173	1013	9.55	8.59	-160	0.246	-650
Ach7	9	1400	1382	10.74	10.65	-18	0.075	-241
Ach8	2	1494	1153	11.17	9.44	-341	0.059	-5780
Ach9	1	1053	1253	8.84	9.99	200	0.099	2020
Ach10	5	1461	1365	11.02	10.57	-96	0.048	-2017
Total	61	1385	1361	10.66	10.54	-24	0.101	-241
SD		172.01	236.07	0.82	1.12	290.23	0.06	3658.77

P.7.1 F1 ROC from Ach /ui/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	0	Not found.						
Ach3	0	Not found.						
Ach4	0	Not found.						
Ach5	0	Not found.						
Ach6	0	Not found.						
Ach7	1	453	453	4.32	4.32	0	0.073	0
Ach8	0	Not found.						
Ach9	0	Not found.						
Ach10	0	Not found.						
Total	1	453	453	4.32	4.32	0	0.073	0
SD		0.00	0.00	0.00	0.00	0.00	0.00	0.00

P.7.2 F2 ROC from Ach /ui/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	0	Not found.						
Ach3	0	Not found.						
Ach4	0	Not found.						
Ach5	0	Not found.						
Ach6	0	Not found.						
Ach7	1	1213	1774	9.77	12.32	561	0.073	7685
Ach8	0	Not found.						
Ach9	0	Not found.						
Ach10	0	Not found.						
Total	1	1213	1774	9.77	12.32	561	0.073	7685
SD		0.00	0.00	0.00	0.00	0.00	0.00	0.00

P.8.1 F1 ROC from Ach /əi/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	2	613	533	5.69	5.02	-80	0.079	-1013
Ach3	3	653	573	6.02	5.36	-80	0.113	-710

‘Appendix P.8.1, continued’

Ach4	3	640	506	5.91	4.79	-133	0.130	-1028
Ach5	1	653	573	6.02	5.36	-80	0.124	-645
Ach6	0	Not found.						
Ach7	2	633	653	5.85	6.02	20	0.109	183
Ach8	1	653	573	6.02	5.36	-80	0.076	-1053
Ach9	1	653	533	6.02	5.02	-120	0.105	-1143
Ach10	1	613	493	5.69	4.68	-120	0.108	-1111
Total	14	639	556	5.90	5.22	-83	0.108	-765
SD		25.33	66.03	0.20	0.55	70.97	0.04	893.04

P.8.2 F2 ROC from Ach /əi/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	2	1914	2474	12.82	14.45	560	0.079	7089
Ach3	3	1587	2187	11.58	13.68	600	0.113	5325
Ach4	3	1819	2276	12.49	13.93	457	0.130	3522
Ach5	1	1774	2694	12.32	14.96	920	0.124	7419
Ach6	0	Not found.						
Ach7	2	1634	2054	11.77	13.28	420	0.109	3853
Ach8	1	1534	2614	11.35	14.78	1080	0.076	14211
Ach9	1	1734	2334	12.17	14.08	600	0.105	5714
Ach10	1	1774	2975	12.32	15.55	1201	0.108	11120
Total	14	1724	2362	12.13	14.16	637.93	0.108	5891
SD		144.15	327.59	0.55	0.89	320.81	0.04	3422.35

P.9.1 F1 ROC from Ach /oi/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	1	453	573	4.32	5.36	120	0.136	882
Ach3	0	Not found.						
Ach4	0	Not found.						
Ach5	0	Not found.						
Ach6	0	Not found.						
Ach7	0	Not found.						
Ach8	6	560	506	5.25	4.79	-53.5	0.0845	-633
Ach9	0	Not found.						
Ach10	1	573	453	5.36	4.32	-120	0.102	-1176
Total	8	548	508	5.15	4.81	-40	0.093	-431
SD		42.51	106.77	0.37	0.90	121.04	0.04	1687.37

P.9.2 F2 ROC from Ach /oi/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	0	Not found.						
Ach2	1	1293	2014	10.20	13.15	721	0.136	5301
Ach3	0	Not found.						
Ach4	0	Not found.						
Ach5	0	Not found.						
Ach6	0	Not found.						
Ach7	0	Not found.						
Ach8	6	1266.5	2240.67	10.06	13.83	974	0.0845	11529
Ach9	0	Not found.						
Ach10	1	1133	2854	9.32	15.31	1721	0.102	16873
Total	8	1253	2289	9.99	13.96	1036	0.093	11123
SD		109.34	374.28	0.56	1.06	468.40	0.04	7442.26

P.10 Ach /ʌi/

Not found in data.

P.11 Ach /ɔi/

Not found in data.

P.12.1 F1 ROC from Ach /ai/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
Ach1	11	831	620	7.37	5.75	-211	0.085	-2487
Ach2	23	895	569	7.81	5.33	-325	0.113	-2887
Ach3	19	904	579	7.87	5.41	-324	0.112	-2887
Ach4	14	907	679	7.90	6.22	-229	0.102	-2247
Ach5	5	781	541	7.00	5.09	-240	0.160	-1498
Ach6	1	773	573	6.94	5.36	-200	0.096	-2083
Ach7	9	817	729	7.27	6.61	-89	0.068	-1311
Ach8	7	802	556	7.15	5.22	-246	0.107	-2303
Ach9	2	733	653	6.64	6.02	-80	0.077	-1039
Ach10	13	776	625	6.97	5.79	-151	0.117	-1292
Total	104	854	611	7.53	5.68	-242	0.106	-2290
SD		93.93	109.79	0.66	0.89	133.42	0.04	1609.02

P.12.2 F2 ROC from Ach /ai/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
Ach1	11	1949	2247	12.94	13.85	298	0.085	3516
Ach2	23	1955	2414	12.96	14.29	459	0.113	4075
Ach3	19	2012	2406	13.14	14.27	394	0.115	3425
Ach4	14	1957	2268	12.96	13.91	311	0.102	3062
Ach5	5	1950	2718	12.93	15.00	768	0.160	4838
Ach6	1	2054	3015	13.28	15.63	961	0.096	10010
Ach7	9	2036	2298	13.22	13.99	262	0.068	3863
Ach8	7	1911	2323	12.81	14.05	411	0.107	3855
Ach9	2	1794	2494	12.39	14.49	700	0.077	9091
Ach10	13	2039	2500	13.23	14.51	462	0.117	3956
Total	104	1977	2392	13.03	14.24	415	0.106	3900
SD		137.29	280.05	0.43	0.73	302.97	0.04	3030.72

APPENDIX Q

KpA diphthongs measurements from INT in average values:

Q.1.1 F1 ROC from KpA /iə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	1	493	493	4.68	4.68	0	0.089	0
KpA2	8	488	503	4.63	4.76	15	0.106	141
KpA3	1	493	493	4.68	4.68	0	0.073	0
KpA4	4	503	503	4.76	4.76	0	0.103	0
KpA5	0	Not found.						
KpA6	2	453	453	4.32	4.32	0	0.062	0
KpA7	8	493	503	4.68	4.76	10	0.071	141
KpA8	9	484	515	4.60	4.87	31	0.061	513
KpA9	5	485	525	4.61	4.95	40	0.076	529
KpA10	1	533	493	5.02	4.68	-40	0.066	-606
Total	39	489	505	4.64	4.78	16	0.080	206
SD		30.15	34.52	0.26	0.30	37.52	0.04	629.44

Q.1.2 F2 ROC from KpA /iə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	1	2814	2814	15.22	15.22	0	0.089	0
KpA2	8	2629	2764	14.82	15.12	135	0.106	1271
KpA3	1	3215	3215	16.01	16.01	0	0.073	0
KpA4	4	2614	2614	14.78	14.78	0	0.103	2
KpA5	0	Not found.						
KpA6	2	2674	2554	14.92	14.64	-120	0.062	-1935
KpA7	8	2834	2729	15.27	15.04	-105	0.071	-1477
KpA8	9	2378	2276	14.20	13.93	-102	0.061	-1685
KpA9	5	2758	2822	15.10	15.24	64	0.076	849
KpA10	1	2894	2734	15.39	15.05	-160	0.066	-2424
Total	39	2657	2638	14.88	14.84	-19	0.080	-243
SD		217.95	309.79	0.49	0.75	194.16	0.04	3306.45

Q.2.1 F1 ROC from KpA /ɯə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	17	517	519	4.88	4.90	2	0.070	-15
KpA2	7	510	544	4.82	5.12	34	0.088	343
KpA3	5	549	573	5.16	5.36	24	0.080	735
KpA4	7	553	553	5.19	5.19	0	0.084	0
KpA5	12	533	553	5.02	5.19	20	0.082	275
KpA6	7	493	510	4.67	4.82	17	0.092	256
KpA7	11	537	544	5.05	5.11	7	0.063	135
KpA8	8	533	533	5.02	5.02	0	0.075	-44
KpA9	13	539	533	5.07	5.02	-6	0.068	-121
KpA10	10	529	521	4.99	4.92	-8	0.064	-127
Total	97	528	535	4.98	5.04	7	0.074	94
SD		33.61	31.52	0.29	0.27	34.16	0.03	538.07

Q.2.2 F2 ROC from KpA /ɯə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	17	1717	1847	11.97	12.45	130	0.070	1748
KpA2	7	1951	1888	12.93	12.68	-63	0.088	-407
KpA3	5	1854	1910	12.56	12.70	56	0.080	-2793
KpA4	7	1814	1841	12.46	12.56	27	0.084	263
KpA5	12	1934	1831	12.85	12.50	-103	0.082	-1757
KpA6	7	2020	1980	13.11	12.96	-40	0.092	-987
KpA7	11	1876	1930	12.61	12.83	55	0.063	1048
KpA8	8	1779	1874	12.27	12.64	95	0.075	1055
KpA9	13	2042	2017	13.23	13.11	-25	0.067	-327
KpA10	10	1956	1936	12.95	12.88	-20	0.064	-418
Total	97	1890	1904	12.73	12.79	15	0.074	201
SD		242.37	233.93	0.91	0.81	230.8	0.03	3946.78

Q.3.1 F1 ROC from KpA /uə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	2	473	493	4.50	4.68	20	0.061	331
KpA2	10	501	529	4.75	4.99	28	0.140	201
KpA3	6	513	513	4.85	4.85	0	0.120	0

‘Appendix Q.3.1, continued’

KpA4	6	486	493	4.62	4.68	7	0.079	85
KpA5	7	504	533	4.77	5.02	29	0.103	276
KpA6	4	503	493	4.76	4.68	-10	0.077	-130
KpA7	6	520	513	4.91	4.85	-7	0.061	-109
KpA8	9	493	511	4.68	4.83	18	0.064	276
KpA9	48	500	509	4.73	4.81	9	0.075	122
KpA10	3	493	466	4.68	4.44	-27	0.104	-256
Total	101	500	510	4.74	4.82	10	0.085	116
SD		30.67	41.70	0.27	0.36	38.95	0.06	571.45

Q.3.2 F2 ROC from KpA /uə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	2	1214	1113	9.78	9.20	-101	0.061	-1661
KpA2	10	1273	1205	10.10	9.73	-68	0.087	-787
KpA3	6	1273	1340	10.10	10.44	67	0.120	558
KpA4	6	1140	1413	9.36	10.80	274	0.079	3486
KpA5	7	1299	1402	10.23	10.74	103	0.103	999
KpA6	4	1263	1323	10.04	10.35	60	0.077	782
KpA7	6	1440	1320	10.93	10.34	-121	0.061	-1984
KpA8	9	1324	1511	10.36	11.25	187	0.064	2902
KpA9	48	1340	1312	10.44	10.30	-28	0.075	-368
KpA10	3	1200	1213	9.70	9.78	14	0.104	131
Total	101	1309	1327	10.29	10.38	18	0.080	223
SD		137.17	220.13	0.71	1.05	241.03	0.03	3547.76

Q.4.1 F1 ROC from KpA /ɛə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	10	605	573	5.63	5.36	-32	0.105	-304
KpA2	28	636	634	5.88	5.87	-1	0.116	-12
KpA3	15	618	621	5.73	5.76	3	0.090	30
KpA4	6	653	660	6.02	6.07	7	0.159	42
KpA5	16	628	661	5.81	6.08	33	0.155	210
KpA6	7	590	567	5.50	5.31	-23	0.071	-323
KpA7	34	631	632	5.84	5.84	1	0.092	13
KpA8	25	587	616	5.48	5.72	29	0.084	343
KpA9	24	608	601	5.65	5.60	-7	0.081	-82
KpA10	15	610	596	5.67	5.55	-14	0.105	-136
Total	180	617	620	5.73	5.75	3	0.102	26
SD		38.17	66.56	0.31	0.53	55.06	0.07	718.39

Q.4.2 F2 ROC from KpA /ɛə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	10	2446	2270	14.38	13.91	-176	0.105	-1671
KpA2	28	2528	2355	14.58	14.14	-173	0.116	-1489
KpA3	15	2593	2529	14.73	14.58	-64	0.090	-711
KpA4	6	2501	2394	14.51	14.24	-107	0.122	-873
KpA5	16	2674	2622	14.92	14.80	-53	0.155	-339
KpA6	7	2437	2260	14.35	13.88	-177	0.071	-2500
KpA7	34	2536	2384	14.60	14.22	-152	0.092	-1649
KpA8	25	2403	2284	14.27	13.95	-118	0.084	-1411
KpA9	24	2596	2571	14.74	14.68	-25	0.081	-308
KpA10	15	2508	2268	14.53	13.91	-240	0.105	-2290
Total	180	2530	2404	14.58	14.27	-126	0.101	-1254
SD		186.41	268.84	0.46	0.72	224.21	0.07	3392.01

Q.5 KpA /ʌə/

Not found in data.

Q.6.1 F1 ROC from KpA /ɔə/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	6	666	620	6.12	5.75	-47	0.124	-377
KpA2	4	663	683	6.10	6.25	20	0.118	169
KpA3	8	618	623	5.73	5.77	5	0.139	36
KpA4	5	669	645	6.14	5.95	-24	0.130	-185
KpA5	5	653	605	6.02	5.63	-48	0.135	-355
KpA6	3	626	693	5.80	6.33	67	0.083	803
KpA7	3	626	600	5.80	5.58	-27	0.109	-245
KpA8	7	602	602	5.60	5.60	0	0.072	0
KpA9	16	611	598	5.67	5.57	-13	0.083	-151
KpA10	1	693	693	6.33	6.33	0	0.075	0
Total	58	632	621	5.84	5.76	-10	0.106	-98
SD		45.09	58.88	0.36	0.48	68.49	0.06	866.41

Q.6.2 F2 ROC from KpA /ɔə/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	6	1360	1474	10.54	11.08	114	0.124	917
KpA2	4	1444	1704	10.94	12.05	260	0.118	2199
KpA3	8	1371	1739	10.59	12.19	368	0.139	2644
KpA4	5	1317	1253	10.33	9.99	-64	0.130	-492
KpA5	5	1237	1365	9.90	10.57	128	0.135	948
KpA6	3	1373	1467	10.61	11.05	94	0.083	1129
KpA7	3	1386	1600	10.67	11.63	214	0.109	1963
KpA8	7	1373	1465	10.61	11.04	92	0.072	1274
KpA9	16	1449	1481	10.96	11.11	33	0.083	392
KpA10	1	1614	1213	11.69	9.77	-401	0.075	-5347
Total	58	1385	1500	10.66	11.20	115	0.106	1087
SD		161.47	290.72	0.76	1.26	281.37	0.06	3082.84

Q.7.1 F1 ROC from KpA /ui/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	0	Not found.						
KpA2	0	Not found.						
KpA3	0	Not found.						
KpA4	0	Not found.						
KpA5	0	Not found.						
KpA6	0	Not found.						
KpA7	0	Not found.						
KpA8	0	Not found.						
KpA9	1	453	413	4.32	3.96	-40	0.093	-430
KpA10	0	Not found.						
Total	1	453	413	4.32	3.96	-40	0.093	-430
SD		0.00	0.00	0.00	0.00	0.00	0.00	0.00

Q.7.2 F2 ROC from KpA /ui/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	0	Not found.						
KpA2	0	Not found.						
KpA3	0	Not found.						

‘Appendix Q.7.2, continued’

KpA4	0	Not found.						
KpA5	0	Not found.						
KpA6	0	Not found.						
KpA7	0	Not found.						
KpA8	0	Not found.						
KpA9	1	1253	2854	9.99	15.31	1601	0.093	17215
KpA10	0	Not found.						
Total	1	1253	2854	9.99	15.31	1601	0.093	17215
SD		0.00	0.00	0.00	0.00	0.00	0.00	0.00

Q.8.1 F1 ROC from KpA /əi/*

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	2	553	573	5.19	5.36	20	0.133	150
KpA2	5	541	557	5.09	5.23	16	0.102	157
KpA3	0	Not found.						
KpA4	3	573	520	5.36	4.91	-53	0.122	-437
KpA5	1	533	493	5.02	4.68	-40	0.104	-385
KpA6	0	Not found.						
KpA7	0	Not found.						
KpA8	0	Not found.						
KpA9	1	573	533	5.36	5.02	-40	0.121	-331
KpA10	0	Not found.						
Total	12	553	543	5.19	5.11	-10	0.114	-88
SD		20.89	54.27	0.18	0.45	59.39	0.03	548.23

* all /əi/ in the words were realized as /oi/

Q.8.2 F2 ROC from KpA /əi/*

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	2	1273	2374	10.10	14.19	1101	0.133	8278
KpA2	5	1229	2350	9.86	14.13	1121	0.102	11033
KpA3	0	Not found.						
KpA4	3	1226	2681	9.85	14.93	1454	0.122	11921
KpA5	1	1133	2614	9.32	14.78	1481	0.104	14240
KpA6	0	Not found.						
KpA7	0	Not found.						

‘Appendix *.8.2, continued’

KpA8	0	Not found.						
KpA9	1	1253	3175	9.99	15.93	1922	0.121	15884
KpA10	0	Not found.						
Total	12	1230	2527	9.86	14.58	1298	0.114	11409
SD		118.73	276.73	0.66	0.64	293.4	0.03	3336.58

* all /əi/ in the words were realized as /oi/

Q.9.1 F1 ROC from KpA /oi/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	7	573	568	5.36	5.32	-5	0.120	-41
KpA2	10	557	553	5.23	5.19	-4	0.130	-31
KpA3	0	Not found.						
KpA4	5	557	565	5.23	5.29	8	0.135	59
KpA5	3	493	533	4.68	5.02	40	0.097	414
KpA6	0	Not found.						
KpA7	1	533	453	5.02	4.32	-80	0.065	-1231
KpA8	0	Not found.						
KpA9	2	533	533	5.02	5.02	0	0.112	0
KpA10	1	533	493	5.02	4.68	-40	0.059	-678
Total	29	551	550	5.17	5.16	-1.172	0.119	-10
SD		33.10	79.40	0.28	0.66	73.99	0.04	728.73

Q.9.2 F2 ROC from KpA /oi/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	7	1322	2351	10.35	14.13	1029	0.120	8588
KpA2	10	1305	2242	10.26	13.83	937	0.130	7228
KpA3	0	Not found.						
KpA4	5	1237	2662	9.90	14.89	1425	0.135	10571
KpA5	3	1240	2601	9.92	14.75	1361	0.097	14079
KpA6	0	Not found.						
KpA7	1	1173	1894	9.55	12.75	721	0.065	11092
KpA8	0	Not found.						
KpA9	2	1273	3015	10.10	15.63	1742	0.112	15549
KpA10	1	1494	2094	11.17	13.40	600	0.059	10169
Total	29	1290	2414	10.19	14.29	1124	0.119	9453
SD		121.19	364.65	0.63	1.05	402.50	0.04	3751.81

Q.10 KpA /ʌi/

Not found in data.

Q.11 KpA /ɔi/

Not found in data.

Q.12.1 F1 ROC from KpA /ai/

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KpA1	11	715	617	6.50	5.72	-98	0.096	-1024
KpA2	7	802	739	7.15	6.68	-63	0.123	-509
KpA3	17	766	669	6.89	6.15	-96	0.155	-621
KpA4	7	847	687	7.48	6.29	-160	0.129	-1239
KpA5	4	823	733	7.31	6.64	-90	0.096	-940
KpA6	4	783	653	7.02	6.02	-130	0.098	-1330
KpA7	6	793	646	7.09	5.96	-147	0.171	-860
KpA8	7	682	630	6.24	5.83	-51	0.132	-389
KpA9	25	848	669	7.49	6.14	-179	0.106	-1696
KpA10	9	769	706	6.91	6.44	-62	0.148	-421
Total	97	789	671	7.06	6.16	-118	0.125	-941
SD		102.23	114.01	0.75	0.90	120.74	0.07	1340.29

Q.12.2 F2 ROC from KpA /ai/

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KpA1	11	2010	2276	13.14	13.93	265	0.096	2768
KpA2	7	1911	2168	12.81	13.62	257	0.123	2083
KpA3	17	2080	2405	13.36	14.27	325	0.155	2091
KpA4	7	1911	2437	12.81	14.35	526	0.129	4072
KpA5	4	1854	2594	12.61	14.73	740	0.096	7728
KpA6	4	1924	2504	12.85	14.52	580	0.098	5934
KpA7	6	1987	2424	13.06	14.32	437	0.171	2561
KpA8	7	1905	2100	12.79	13.42	194	0.132	1469
KpA9	25	1995	2502	13.09	14.51	507	0.106	4799
KpA10	9	1952	2214	12.95	13.75	262	0.148	1774
Total	97	1980	2374	13.04	14.19	394	0.125	3144
SD		173.59	250.70	0.65	0.66	284.00	0.07	3636.54

APPENDIX R

SM monophthongs measurements in average values:

R.1 SM /i/ from *pita* [pita] 'tape, ribbon'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
SM1	3	0.116	444	2778	4.24	15.15
SM2	3	0.083	421	2742	4.03	15.07
SM3	3	0.077	420	2588	4.03	14.72
Total	9	0.092	428	2703	4.10	14.98
SD		0.02	18.58	90.55	0.17	0.20

R.2 SM /e/ from *beta* [beta] 'I, me (for royalty)'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
SM1	3	0.127	551	2385	5.17	14.22
SM2	3	0.101	563	2564	5.28	14.66
SM3	3	0.101	587	2302	5.48	14.00
Total	9	0.110	567	2417	5.31	14.30
SD		0.01	18.97	122.19	0.16	0.31

R.3 SM /ə/ from *peta* [pəta] 'map'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
SM1	3	0.090	575	1826	5.38	12.51
SM2	3	0.068	599	2004	5.58	13.12
SM3	3	0.058	575	1837	5.38	12.55
Total	9	0.072	583	1889	5.44	12.73
SD		0.02	28.14	91.15	0.23	0.31

R.4 SM /a/ from *batu* [batu] 'rock'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
SM1	3	0.148	980	1742	8.38	12.20
SM2	3	0.112	956	1707	8.23	12.06
SM3	3	0.101	909	1671	7.91	11.92
Total	9	0.121	948	1706	8.17	12.06
SD		0.02	32.96	39.88	0.22	0.16

R.5 SM /u/ from *buta* [buta] 'blind'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
SM1	0.104	480	1087	4.56	9.05	0.104
SM2	0.108	480	992	4.56	8.46	0.108
SM3	0.097	444	1004	4.25	8.54	0.097
Total	0.103	468	1028	4.46	8.69	0.103
SD		0.01	25.16	50.41	0.22	0.31

R.6 SM /o/ from *kota* [kota] 'city'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
SM1	3	0.160	622	1206	5.76	9.74
SM2	3	0.123	563	1159	5.28	9.47
SM3	3	0.106	551	1182	5.17	9.60
Total	9	0.130	579	1182	5.41	9.60
SD		0.02	34.51	24.99	0.29	0.14

APPENDIX S

SM diphthongs measurements in average values:

S.1.1 F1 ROC from SM /ai/ from *lambai* [lambai] 'wave'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
SM1	3	897	575	7.83	5.38	-322	0.126	-2546
SM2	3	897	492	7.83	4.67	-405	0.110	-3682
SM3	3	849	504	7.50	4.77	-345	0.147	-2352
Total	9	881	524	7.72	4.94	-357	0.128	-2798
SD		39.00	42.80	0.27	0.37	56.69	0.02	695.25

S.1.2 F2 ROC from SM /ai/ from *lambai* [lambai] 'wave'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
SM1	3	1766	2467	12.29	14.43	701	0.126	5546
SM2	3	1730	2623	12.15	14.80	893	0.11	8118
SM3	3	1778	2611	12.33	14.77	833	0.147	5682
Total	9	1758	2567	12.26	14.67	809	0.128	6337
SD		52.84	103.52	0.20	0.25	114.87	0.02	1671.15

S.2.1 F1 ROC from SM /au/ from *kerbau* [kerbau] 'buffalo'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
SM1	3	873	563	7.66	5.28	-310	0.147	-2109
SM2	3	873	563	7.66	5.28	-310	0.113	-2735
SM3	3	813	480	7.24	4.56	-333	0.154	-2165
Total	9	853	535	7.52	5.04	-318	0.138	-2301
SD		36.32	47.56	0.26	0.41	33.11	0.02	500.39

S.2.2 F2 ROC from SM /au/ from *kerbau* [kerbau] 'buffalo'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
SM1	3	1611	1159	11.68	9.47	-452	0.147	-3077
SM2	3	1504	1182	11.22	9.60	-322	0.113	-2838
SM3	3	1516	1087	11.27	9.05	-428	0.154	-2781
Total	9	1544	1143	11.39	9.38	-401	0.138	-2902
SD		79.39	71.54	0.33	0.41	75.15	0.02	494.68

S.3.1 F1 ROC from SM /oi/ from *amboi* [amboi] 'expression of surprise'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
SM1	3	587	575	5.48	5.38	-12	0.100	-120
SM2	3	587	504	5.48	4.77	-83	0.091	-915
SM3	3	528	456	4.98	4.35	-71	0.121	-590
Total	9	567	512	5.31	4.84	-55	0.104	-534
SD		31.34	57.54	0.27	0.50	47.32	0.02	452.54

S.3.2 F2 ROC from SM /oi/ from *amboi* [amboi] 'expression of surprise'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
SM1	3	1230	2421	9.87	14.31	1191	0.100	11910
SM2	3	-915	1159	2552	9.47	14.63	1393	0.091
SM3	3	-590	1135	2481	9.33	14.46	1346	0.121
Total	9	1175	2484	9.56	14.47	1310	0.104	12609
SD		59.53	112.08	0.34	0.28	134.73	0.02	2123.63

APPENDIX T

KD monophthongs measurements in average values:

T.1 KD /i/ from *pita* [pita] 'tape, ribbon'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.088	372	2730	3.59	15.04
KD2	3	0.134	444	2683	4.24	14.94
KD3	3	0.086	397	2933	3.82	15.47
Total	9	0.103	404	2782	3.89	15.16
SD		0.03	37.64	120.17	0.34	0.25

T.2 KD /e/ from *beta* [beta] 'I, me (for royalty)'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.108	504	2576	4.77	14.69
KD2	3	0.114	539	2516	5.08	14.55
KD3	3	0.111	504	2635	4.77	14.83
Total	9	0.111	516	2576	4.87	14.69
SD		0.01	25.10	67.02	0.22	0.16

T.3 KD /ɛ/ from *bebeh* [bɛbɛɦ] 'bottom lip out'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.113	599	2492	5.58	14.49
KD2	3	0.131	611	2541	5.67	14.61
KD3	3	0.122	587	2528	5.48	14.58
Total	9	0.122	599	2520	5.58	14.56
SD		0.01	18.00	49.01	0.15	0.12

T.4 KD /ə/ from *peta* [pəta] 'map'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.079	551	1897	5.17	12.76
KD2	3	0.087	599	1920	5.57	12.84
KD3	3	0.054	528	1980	4.98	13.04
Total	9	0.073	559	1932	5.24	12.88
SD		0.02	34.44	73.73	0.29	0.25

T.5 KD /a/ from *batu* [batu] 'rock'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.118	813	1894	7.24	12.75
KD2	3	0.174	873	1754	7.66	12.24
KD3	3	0.136	897	1921	7.83	12.84
Total	9	0.143	861	1856	7.58	12.62
SD		0.03	53.58	92.62	0.38	0.33

T.6 KD /u/ from *buta* [buta] 'blind'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.084	409	1087	3.93	9.05
KD2	3	0.115	444	1075	4.24	8.98
KD3	3	0.105	409	993	3.93	8.46
Total	9	0.102	421	1052	4.03	8.83
SD		0.02	17.59	50.12	0.16	0.31

T.7 KD /o/ from *kota* [kota] 'city'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.123	492	1147	4.67	9.40
KD2	3	0.180	504	1135	4.77	9.33
KD3	3	0.151	516	1194	4.88	9.67
Total	9	0.151	504	1159	4.77	9.47
SD		0.03	18.00	35.50	0.16	0.20

T.8 KD /ɔ/ from *bodong* [bɔdɔŋ] 'a group of fish'

Language Consultant	Number of Tokens	Ave. Duration	Ave. F1 (Hz)	Ave. F2 (Hz)	Ave. F1 (Bark)	Ave. F2 (Bark)
KD1	3	0.143	587	1123	5.48	9.26
KD2	3	0.142	611	1194	5.67	9.67
KD3	3	0.167	587	1242	5.48	9.93
Total	9	0.151	595	1186	5.54	9.63
SD		0.02	15.87	66.33	0.13	0.37

APPENDIX U

KD diphthongs measurements in average values:

U.1.1 F1 ROC from KD /ai/ from *lambai* [lambai] 'wave'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KD1	3	873	516	7.66	4.87	-357	0.176	-2034
KD2	3	921	432	7.99	4.14	-488	0.195	-2504
KD3	3	861	456	7.58	4.35	-405	0.103	-3945
Total	9	885	468	7.75	4.46	-417	0.158	-2642
SD		47.09	43.68	0.33	0.38	75.64	0.04	1065.91

U.1.2 F2 ROC from KD /ai/ from *lambai* [lambai] 'wave'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KD1	3	2040	2826	13.23	15.25	786	0.176	4474
KD2	3	1921	2814	12.84	15.22	893	0.195	4579
KD3	3	1956	2873	12.96	15.35	917	0.103	8932
Total	9	1972	2838	13.01	15.27	865	0.158	5485
SD		63.69	90.95	0.21	0.19	95.74	0.04	2316.05

U.2.1 F1 ROC from KD /au/ from *kerbau* [kerbau] 'buffalo'

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KD1	3	897	528	7.83	4.98	-369	0.180	-2050
KD2	3	849	468	7.50	4.46	-381	0.188	-2025
KD3	3	837	456	7.41	4.35	-381	0.117	-3259
Total	9	861	484	7.58	4.60	-377.22	0.162	-2332
SD		47.09	41.80	0.33	0.37	31.59	0.04	629.01

U.2.2 F2 ROC from KD /au/ from *kerbau* [kerbau] ‘buffalo’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KD1	3	1659	933	11.87	8.07	-726	0.180	-4035
KD2	3	1599	1135	11.63	9.33	-464	0.188	-2465
KD3	3	1778	1099	12.33	9.12	-679	0.117	-5803
Total	9	1679	1056	11.95	8.86	-623	0.162	-3852
SD		89.56	131.85	0.36	0.83	150.73	0.04	1509.29

U.3.1 F1 ROC from KD /ui/ from *bui* [bui] ‘give, offer’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KD1	3	504	527	4.77	4.97	23	0.206	113
KD2	3	504	456	4.77	4.35	-48	0.293	-164
KD3	3	432	420	4.14	4.03	-12	0.176	-68
Total	9	480	468	4.56	4.46	-12	0.230	-54
SD		40.03	64.32	0.35	0.56	56.55	0.07	258.89

U.3.2 F2 ROC from KD /ui/ from *bui* [bui] ‘give, offer’

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KD1	3	1170	2778	9.54	15.15	1608	0.206	7817
KD2	3	1064	2695	8.91	14.97	1631	0.293	5568
KD3	3	1075	2921	8.98	15.45	1846	0.176	10467
Total	9	1103	2798	9.15	15.19	1694.89	0.225	7533
SD		104.13	106.24	0.59	0.23	142.80	0.07	2306.94

U.4.1 F1 ROC from KD /oi/ from *amboi* [amboi] ‘expression of surprise’

LC	No. of Tokens	Ave. Beg F1 (Hz)	Ave. End F1 (Hz)	Ave. Beg F1 (Bark)	Ave. End F1 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F1 ROC (Hz/sec)
KD1	3	539	528	5.08	4.98	-12	0.213	-55
KD2	3	551	456	5.17	4.35	-95	0.184	-514
KD3	3	528	432	4.98	4.14	-95	0.118	-806
Total	9	539	472	5.08	4.49	-67	0.172	-391
SD		25.10	52.84	0.21	0.46	65.40	0.05	446.06

U.4.2 F2 ROC from KD /oi/ from *amboi* [amboi] 'expression of surprise'

LC	No. of Tokens	Ave. Beg F2 (Hz)	Ave. End F2 (Hz)	Ave. Beg F2 (Bark)	Ave. End F2 (Bark)	Ave. Dif.	Ave. Dur.	Ave. F2 ROC (Hz/sec)
KD1	3	1218	2838	9.80	15.27	1620	0.213	7606
KD2	3	1206	2683	9.74	14.94	1477	0.184	8025
KD3	3	1194	2814	9.67	15.22	1620	0.118	13687
Total	9	1206	2778	9.74	15.15	1572	0.172	9152
SD		56.74	81.91	0.32	0.18	101.34	0.05	3703.70